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Global biodiversity

An International Forum on the Variety of Life on Earth...
research, conservation and wise use

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Editor's Notebook

Why do we need to discover, name, and classify species?

When people learn that only about five per cent of the world's estimated 10 to 100 million species have been discovered, scientifically named, and classified, some people ask, "Why do we need to have a name for every species?" A good question that deserves a good answer. As a biosystematist, I answer:

Identification. Discovering, describing, and naming a new plant or animal enables one to correctly identify species, genera, and families. When a high proportion of species is unnamed, many specimens will be misidentified as identification keys will incorrectly identify some new species with an existing species.

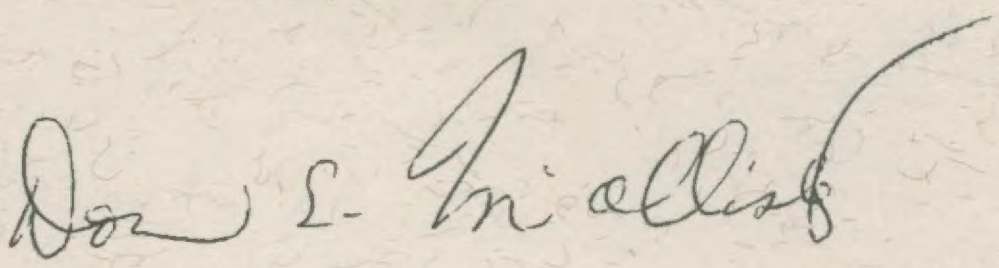
Retrieval of knowledge. The naming of species and classification is done using an internationally recognized cataloguing retrieval system. This universal approach means that new discoveries by ecologists, geneticists, resource managers, and industries can be recorded, retrieved, and shared around the world.

Conservation. It is easier to save individual species when they are named and identifiable. For instance, you can gather information on where the species is found and to changes in its status. And one can prioritize ecosystems, landscapes, or seascapes for conservation by locating hot spots—areas rich in the variety of life—based on knowledge of occurrence of true numbers of species, genera, etc.

Connectedness. Biosystematists discover and map the relationships of the twigs and branches of the tree of life. Ecologists discover the ecological pyramid, or how the components function ecologically and interrelate with one another. These two fundamental kinds of relationships underpin one another.

Predictiveness. Good classifications are predictive. For example, they enable you to predict that another species in the same genus will be a herbivore, a biological control, an edible plant, a source of a healing drug, a nitrogen-fixer, etc. Cladograms, family trees based on a new concept of relatedness, are highly predictive.

We don't have to know every species to save or wisely use some of them. But understanding, good conservation and ecologically sustainable use are greatly enhanced by knowing more rather than few of the species, genera, and other branches of the tree of life. Right now we only know five per cent of the components and even less of their ecological linkages and functions, and so it is difficult to sustain the spaceship Earth. What would you think of a garage mechanic who didn't know the names and functions of most auto components, and who, at the same time, was rapidly losing them? Priority should be given to support for biosystematics, ecology and genetics, to provide the knowledge needed to wisely conserve and use the diversity of life on Earth.



Don E. McAllister
Editor

The goals of Global biodiversity are to:

- *Publish articles, views and news on biodiversity*
- *Bridge the gaps between professional disciplines & the public*
- *Communicate vital information to help humankind make decisions on the fate of the Earth's life*
- *Express views on the needs & value of biodiversity research*
- *Provide an international forum for discussing issues on biodiversity*
- *Enhance awareness of the role of biosystematic research & museum collections to conservation & ecologically sustainable use of biodiversity*
- *Discuss methods and philosophy of biodiversity conservation*
- *Review books and major articles on biodiversity*

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Cover image is a falling dipterocarp, a tree chiefly found in tropical Asia

Global biodiversity

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The Earth Council's first year of operation:

Working with others

The fate of the world hangs on how well the Earth Summit agreements are fulfilled by the signatories. The Earth Council can play a key role in facilitating and monitoring fulfilment of these obligations.

[D.E.M.]

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ASKING FOR DIRECTION AND FORMING A COUNCIL

Working with others is the idea that has dominated the activities of the Secretariat of the Earth Council's Organizing Committee, which was installed on 3 September 1992 in San José, Costa Rica. Only by doing so will the Council be able to effectively follow up the Rio Agreements from an independent perspective.

This principle guided one of the first decisions taken by the Organizing Committee. It consultated with 10,000 organizations around the world to find out whether they felt an Earth Council was needed and their views on its mission. These views were duly considered in designing the future work of the Council. At this time, many of them nominated persons to sit on the Council. In March 1993, the Organizing Committee selected 30 people from 200 nominations, and the Council's 21 members were drawn from this group. The Council met for the first time on 29-30 November 1993.

The Secretariat also received about 2,500 responses, which affirmed that such an institution was needed to act as facilitator, a catalyst, and a watchdog. For one, the respondents drew attention to the lack of formal consideration for many of the achievements of the non-governmental organizations (NGOs) in Rio, such as the 46 NGO treaties and the Agenda 21s prepared by the representatives of the world's women, indigenous peoples, youth, business sector, and scientists. These responses also revealed that very few people and organizations had access to the Rio documents. In addition, respondents felt there was a need for a body to which they could address their grievances and a need for a mechanism to link local concerns and global priorities. In short, the Council could be an organization with an ombudsman-type function.

TAKING ACTION: PROVIDING INFORMATION

Spurred by the conviction that people cannot effectively participate in monitoring if they do not have access to basic information, the Earth Council Secretariat held a second series of consultations. In Costa Rica, for example, a joint project was initiated with a view to increasing the availability of Rio's documents: The authorities of several Costa Rican universities agreed to produce a flyer and a diskette with Rio documents in conjunction with the Earth Council. These are being distributed in English and Spanish to the world's universities, which are expected to make them available to the public.

Another element of the Council's mandate is to evaluate the responses to the Rio challenges on the basis of the testimonies of the people directly affected as well as on professional assessment. This has led to an agreement with the International Council of Scientific Unions (ICSU) and the Third World Academy of Sciences (TWAS) for lectureships and professorships in Science and Sustainable Development aimed at fostering South-South and North-South exchanges.

The Organizing Committee has also been working on a cross-analysis of the 40 chapters of Agenda 21 and existing conventions. The analysis will be sent to a group called Parliamentarians for Global Action, which is made up of individuals who have played a key role with regard to the environment.

TAKING ACTION: DEVELOPING AN EARTH CHARTER

One of the Council's tasks is to stimulate people to produce and revise their own agendas for the 21st century. To this end, the Council and the Latin American ecumenical group, Alfalit, is working with the spiritual leaders of religious, women's, youth, senior citizens, and indigenous organizations to prepare an Earth Charter. This body of ethical guidelines for Sustainable Development should be ready in time for the 50th anniversary of the United Nations in 1995. Its aim is to promote a new global ethic as a decisive factor in developing a new awareness on consumerism, environmental degradation, poverty, and other results of a production model that encourages unjust relations between man and man, between man and nature.

TAKING ACTION: DEVELOPING PACKAGES ON ISSUES

Part of the mandate the Organizing Committee gave the Secretariat was to review and assess relevant issues since Rio. In this regard, the Secretariat has chosen Agenda 21 as its starting point since this is the most comprehensive document of its type ever produced and has received the political support of some 180 governments.

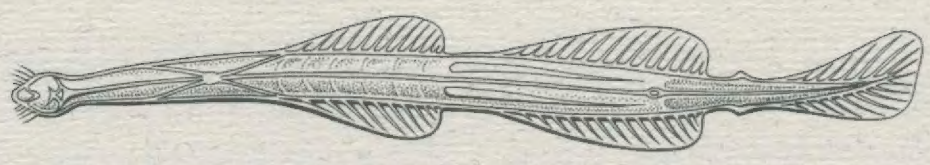
The Secretariat proposes to take selected issues from Agenda 21 and organize them in *packages* centred around a *driving force*. One package links biodiversity, biotechnology, sustainable agriculture, forestry, and desertification around the axis of sustainable agriculture. A second joins climate change, energy efficiency, human settlements, and industrialisation, with energy efficiency as the centrepiece.

In the case of *Sustainable Agriculture*, for example, the actors are farmers and fishers at one level, agri-business at another, and at yet another level, banks, multilateral institutions, and transnationals. The Council's obvious international partners include the Inter-American Institute for Cooperation in Agriculture (IICA) the International Development Research Center (IDRC), Development Alternatives, Africa 2000 and the International Institute for Environmental Development (IIED). Critical geographical areas for agriculture are Africa for desertification and the Americas, where biodiversity is concerned.

Key elements of the assessment will be 1) gathering information on the work of national institutions and international watchdogs, 2) helping to amplify the voices of community-based organizations and 3) linking their concerns to global priorities. In the case of Sustainable Agriculture, this will be done partly by working with indigenous organizations and bodies like the International Council for Local Environmental Initiatives (ICLEI), which groups the world's local authorities. In the case of tourism, the Earth Council is also helping the World Travel and Tourism Council (WTTC) to prepare an Agenda 21 by September 1994. To economically ensure participation, this method of working with global organizations, which also have national constituencies, such as the WTTC and ICLEI, seems to work well.

Access to information and exchanges of viewpoints, of great importance to the review/assessment process, will be facilitated through mechanisms such as public hearings, both global (via satellite) and local, an Earth Council forum, and annual Earth reports. Children, youth, and grass-roots organizations will be encouraged to monitor environmental conditions in their own communities and then have input into the annual Earth reports. The voices of those who are too often unheard will be amplified, so they, too, can be included in policy and decision-making processes.

The Earth Council, now in full swing, benefits from the guidance and support of 13 eminent world leaders, who serve as Honourary Members. In addition, the Council receives special advice and support from a broad-based Earth Council Institute Board, made up of representatives of major environment and development organizations. It's been a busy first year—to say the least. Not only have the structure, goals, and activities of the Earth Council been established, it is already carrying out its vital mission—that of supporting and empowering people in carrying forward the spirit of Rio and fulfilling the promise of the Earth Summit...and building pathways to a more ethical, equitable, secure, and sustainable future.



Capsizing the cradle of life

The planet Earth could more aptly be called Ocean for much of its surface is covered by oceans, ocean life is more diverse and has a greater number of higher taxa than land, and the eco-services provided by the seas are vital to the maintenance and well-being of the Earth. A new emphasis needs to be placed on exploring, understanding, and conserving the ocean realm—inner space. This article, #4 in the Center for Marine Conservation's Contributions in Marine Conservation Biology Series, *does just that.*

[D.E.M.]

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To a mind shaped by land—whether by cities or farms, forests or deserts—it is difficult to imagine a realm on our planet occupied by life that is 500 times as large as the land and freshwaters combined. But there is one: the sea, including estuaries, coastal waters, and the open oceans. Covering some 71% of the Earth's surface to an average depth of about 4 kilometres (Table 1), the marine portion of the biosphere dwarfs the realm we know best.

Table 1. Volume of the Biosphere: % of Nonmarine vs. Marine Ecosystems

Ecosystem Type	**Area (% of Earth's Surface)**[1]	**Average Ecosystem Depth in Metres**	**% of Biosphere Volume**
Forest	10	30	
Woodland,Shrubland, Grassland & Savanna	6	15	
Desert & Tundra	10	10	
Cultivated Land	3	5	
Lakes, Streams & Swamps	1	50	
Total Nonmarine	**29**	**19**	**.2**
Marine	**71**	**4,000**	**99.8**

[1] from Robert H. Whittaker (1970). Communities and Ecosystems. Macmillan, London (UK).
Land numbers add up to more than 29% due to rounding.

	Exclusively Marine	Marine & Non-marine	Exclusively Non-marine
	Placozoa	*Porifera* (Sponges)*	*Onychophora* (Velvet worms)
	Ctenophora (Comb jellies)	*Cnidaria* (Coelanterates, such as jellyfish, corals, etc.)*	
	Mesozoa	*Platyhelminthes* (Flatworms)	
	Gnathostomulida (Marine worms)	*Nemertina* (Ribbon worms)*	
	Kinorhyncha (Tubeworms)	*Gastrotricha* (Gastrotrichs)	
	Loricifera	*Rotifera* (Wheel animals)	
	Phoronida	*Acanthocephala* (Thornyhead worms)	
	Brachiopoda (Lamp shells)	*Entoprocta**	
	Priapulida (Priapus worms)	*Nematoda* (Roundworms)	
	Sipuncula (Peanut worms)	*Nematomorpha* (Horsehair worms)	
	Echiura (Spoon worms)	*Ectoprocta* (Bryozoans)*	
	Pogonophora (Beardworms)	*Mollusca* (Mollusks)	
	Echinodermata (Starfishes, sea urchins, etc.)	*Annelida* (Segmented worms)	
	Chaetognatha (Arrow worms)	*Tardigrada* (Water bears)	
	Hermichordata (Acorn worms)	*Pentastoma* (Tongue worms)	
		Arthropoda (Arthropods)	
		Chordata (Chordates)	
Total Phyla:	**15**	**17**	**1**

* = More than 95% of species are marine.

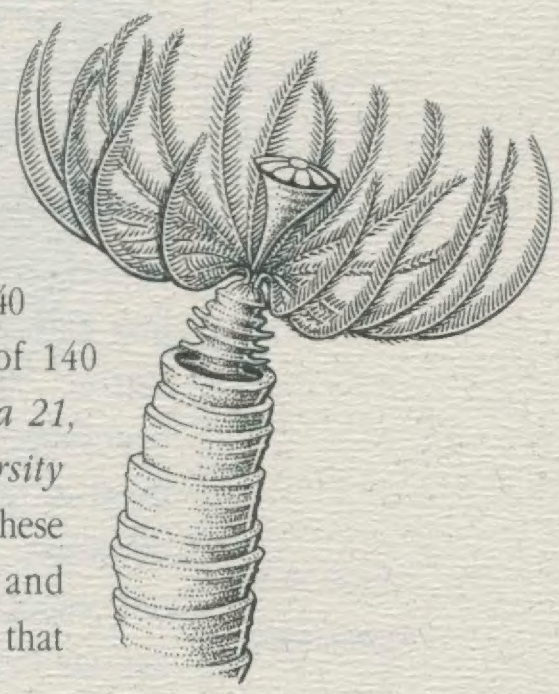
Table 2. Animal phyla in marine and non-marine ecosystems

From the wave-washed intertidal zone to the frigid blackness of oceanic trenches, the sea hosts a dazzling diversity of life. Indeed, life originated in the sea more than 3.5 billion years ago, and only ventured onto land less than 450 million years ago. In other words, for the first 85% of its existence, life was exclusively marine. Marine seaweeds and invertebrates underwent explosive diversification eons before the first cockroach, reptile or tree, and the sea is still home to virtually all extant phyla of animal (Table 2).

The land, in contrast, has astoundingly diverse variations on the theme of insectdom and a wonderful but much more modest diversity of plants and animals in other groups. In the history of diversity on Earth, therefore, life on land is an exciting but brief chapter. Only a peculiar terrestrial perspective and short memory leads to any other conclusion.

Now, *Homo sapiens*—a latecomer even among terrestrial latecomers—is expanding so rapidly that it is capsizing the cradle of life. It has ruptured the sea's freshwater connections with the land and ploughed the seafloor. Its waste products litter the deep sea and contaminate the flesh of marine species even in the world's most remote locations. Its insatiable appetites have reduced once-vast populations to rarity or extinction. From the intertidal zone to the open ocean, its activities are disrupting the patterns and processes of entire ecosystems. *Homo sapiens* is eliminating biological diversity in the sea.

To save our ocean planet from ourselves, to slow and stop this largely overlooked destruction, we need to understand what is being affected, why humans are doing so, and what remedies are available. That is why five organizations—The Center for Marine Conservation, IUCN-World Conservation Union, World Wildlife Fund-US, United Nations Environment Programme and World Bank—joined in sponsoring *Global Marine Biological Diversity: A Strategy for Building Conservation into Decision Making* (Norse, 1993). Three years in the making, the *Strategy*, we are told, is the most comprehensive examination of the value of marine life, its status, and ways to conserve it that has ever been produced. It was written to provide the basis for decision making by 106 experts in marine biology, economics, law, and many other fields, and was reviewed by hundreds of others from a total of more than 40 countries. The *Strategy* provides a set of 140 recommendations that came from *Agenda 21, Caring for the Earth*, the *Global Biodiversity Strategy*, and many other sources. Together, these recommendations for saving, studying, and sustainably using the sea form an agenda that should be usable into the next century.

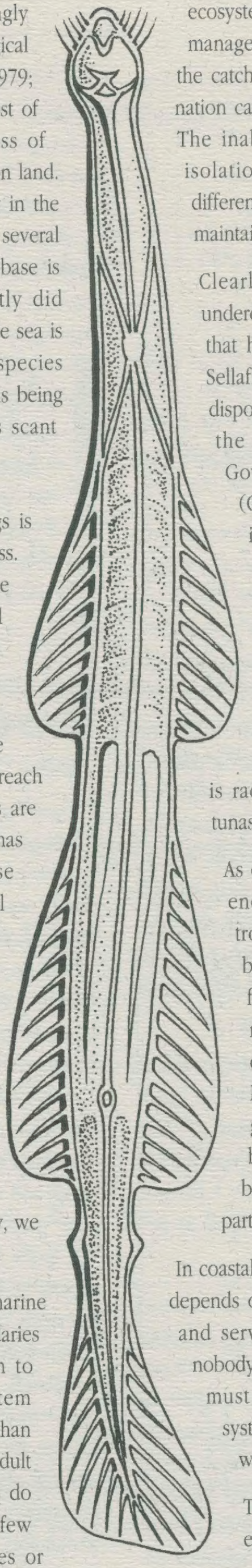


Annelida (segmented worms): *Serpula vermicularis*

In the last 15 years, people have increasingly become aware that the world is losing biological diversity. But from the beginning (Myers 1979; Lovejoy 1980; Norse and McManus 1980), most of the attention has been focused on the loss of tropical forests, the most diverse ecosystems on land. Unfortunately, efforts to conserve biodiversity in the sea lag behind comparable efforts on land by several decades. One reason is that our knowledge base is much smaller. For example, only recently did scientists produce the startling estimate that the sea is home to some 10 million undiscovered species (Grassle and Maciolek, 1992). While the sea is being forced to undergo major changes, there is scant understanding of factors crucial to its integrity.

Another reason that marine conservation lags is that institutions' capacity for action is much less. For example, compared with the albeit scarce resources devoted to protecting biological diversity on land, even fewer, poorer, and weaker resources are devoted to protecting marine ecosystems and species. The people who see the importance of marine conservation are too few and too isolated to reach "critical mass," where their recommendations are heard and acted upon. While conservation has made great strides on land, those whose activities diminish marine biodiversity still have stronger voices. Even the nations that "invented" national parks more than a century ago, such as Canada and the United States, allow commercial activities in the few marine areas they have designated "protected," something they would never permit in their terrestrial parks. Conservation is not free in the sea any more than it is on land. Without dedicated laws, programs, people, and money, we cannot avoid losing the wealth of marine life.

A third reason for the lagging efforts of marine conservation is that national and local boundaries that extend into the sea bear no relation to marine species' ranges and ecosystem boundaries, which are much more extensive than those on land. Planktonic larvae, migrating adult organisms, and pollutants borne by currents do not respect legal borders! Because very few nations that share jurisdiction over species or ecosystems have succeeded in coordinating their management activities—such as those governing the catch of groundfish in the Gulf of Maine—one nation can undermine efforts undertaken by others. The inability of nations to cooperate and the isolation of individuals who could make a difference are among the greatest impediments to maintaining marine biodiversity.



Arrow worm, *Sagitta elegans*

Clearly, our marine environmental ethic is underdeveloped, as people do things in the sea that have become unacceptable on land. From Sellafield (UK) to Valparaiso (Chile), industries dispose of toxic chemicals and nuclear wastes in the sea or in rivers that empty into it. Governments from Cairo (Egypt) to Victoria (Canada) discharge their untreated sewage into biologically diverse coastal waters. Marine recreationists from Miami (USA) and Durban (South Africa) unthinkingly toss their garbage overboard. In countries around the world, there are now laws and peer pressure that protect the top predators on land, such as tigers and wolves, but the fishing industry worldwide is racing to catch the last swordfish, bluefin tunas and sharks, the top predators of the sea.

As on land, the risk in industrialized nations is enormous, but the risk is even higher in tropical developing nations, where marine biotas are still richer and people's desire to fulfill basic needs and "catch up" with richer nations creates unceasing pressure for economic development at any cost. Moreover, threats increasingly occur at a global scale. The cumulative impact of 5.5 billion of us is affecting the entire biosphere, not only the 0.2% (nonmarine part) where which we live.

In coastal and landlocked countries alike, humankind depends on biodiversity in the sea for vital products and services. We have nowhere else to go and nobody else is going to save us from our peril. We must respond to threats to our life support systems, even if it means acknowledging that we are the cause.

There are hopeful signs. The fact that leading environment and development institutions

have produced the *Strategy* is good. The foundation for protecting, studying, and sustainably using the sea has been laid, but the *Strategy*'s benefits will be few and temporary unless individuals and institutions build upon it.

One encouraging development is that the *Strategy*'s co-sponsors and Environment Liaison Centre International in Nairobi (Kenya) are now working to establish the International Marine Conservation Network. The Network aims to bring together a "critical mass" of decision makers in national and local governments, international institutions (such as UN agencies and banks that lend money for development projects), industries, conservation organizations, and academia. This electronic mail is a rapid means of cutting across economic sectors and national boundaries. By helping decision makers coordinate their efforts, it is hoped that the Network will turn recommendations into reality.

We live in an exciting time. With human numbers doubling every 40 years and ever rising consumption of resources, we are overwhelming the planet that supports us. But we are also establishing institutions and processes with which we can address the consequences of what we do, in rainforests and coral reefs, prairies and lakes alike. For the first time since life began 3.5 billion years ago, one species has the power to devastate much of the life on our planet or to save, learn from, and use it sustainably. It will be interesting to see which we choose.

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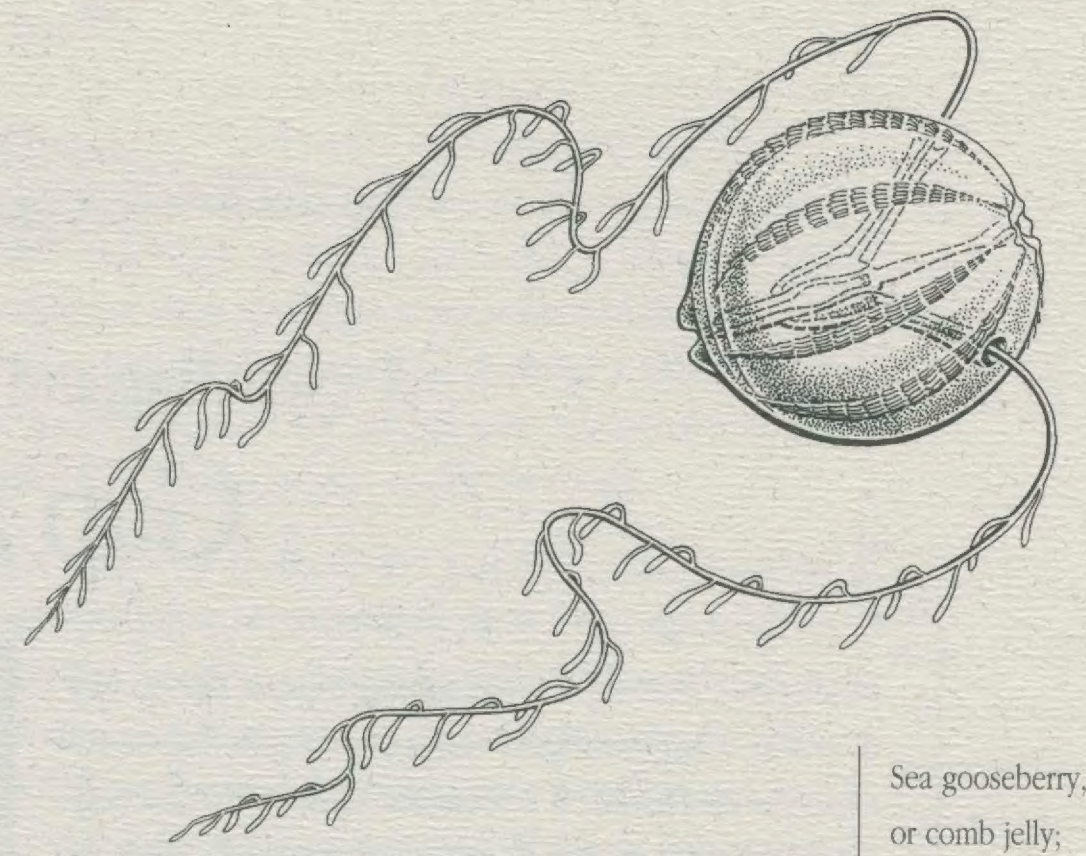
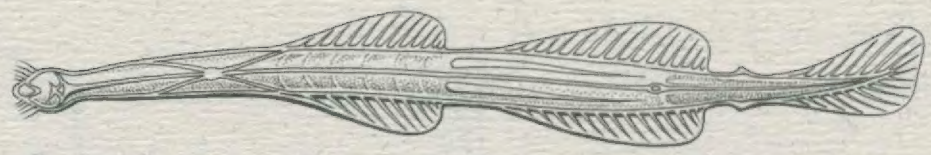


Sea gooseberry, or comb jelly; Ctenophora : *Pleurobrachia*

Echiura: *Bonellia viridis*

Peanut worm; *Sipunculus* sp.



A New England conservation project:

Gap analysis

Biodiversity is being lost too rapidly to save one species at a time. Gap analysis is one tool that can help select areas for protection. It stresses the status of biodiversity based on real world, land cover patterns, such as forests, grasslands, and degree of development. *[D.E.M.]*

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INTRODUCTION

Gap analysis is a strategy for using spatial data for the conservation of nature. Information about plant and animal distributions, land ownership, and land conservation status are standardized independently and conformed for comparative conservation planning. The National Gap Analysis Program is based within the U.S. Biological Survey and projects are under way in 32 states across the U.S.

Specifically, in the northeastern U.S., Gap analysis is currently developing procedures for producing maps, numeric data, and analyses that present the current setting of biodiversity distribution patterns in the six states of the New England region (i.e. Maine, New Hampshire, Vermont, Massachusetts, Connecticut, and Rhode Island). These products and tools will provide invaluable assistance for conservation planning into the 21st century.

BACKGROUND

The U.S. Gap Analysis Program began in the western U.S. late in the 1980s (Scott et al. 1987). Several successful Gap projects have now been under way for several years in Idaho (Butterfield et al. in press), California (Davis and Stoms 1992), Oregon, and Utah, and the Gap Program is now expanding to include all regions in the United States (Kareiva 1993, Pennisi 1993).

New England is a priority site for Gap analysis development because its landscape contrasts in a number of ways from landscape patterns in the western U.S. These differences present new challenges and require distinct strategies. These landscape differences include:

1) the New England landscape is highly fragmented, especially in the southern New England states;
2) New England is extensively forested with a wide variety of forest types;
3) there are relatively few public lands in New England in relation to other parts of the U.S.;
4) the project requires a unique cooperative effort between six states, three U.S. Fish & Wildlife Coop Units, and many other public and private conservation and industry groups.

The New England Gap Analysis Project is considered a pilot project to develop new techniques applicable to future Gap analysis programs throughout the eastern United States where the landscape differs trenchantly from that of the western states. Therefore, an important objective of this project is to evaluate the applicability of the vegetation mapping procedures developed in the western U.S. Gap analysis programs for use in New England. Some of these strategies are not applicable in New England. For example, the precision of the available land-use maps for New England is insufficient for the accuracy requirements of Gap analysis. In addition, many approaches adequate for the western U.S. have proven far too time consuming for the New England region. And so, new strategies are being developed.

The extensive forests of New England produce a landscape with upwards of 70 - 95% forested land cover across the region. Within this cover there is a wide variety of forest types. Many are interspersed on the landscape and occur in relatively small stands. Additionally there is relatively little elevational relief to much of New England. Thus, in contrast to many of the western states, elevation *per se* cannot be used to delineate most of the forest types. Consequently, these regional vegetation characteristics pose several new challenges in the New England Project.

THE NEW ENGLAND APPROACH

The general strategy currently being used in the New England region is illustrated in Figure 1. The categories of vegetation classification are being derived using an unsupervised classification of Thematic Mapper (TM) satellite imagery in combination with spatial and statistical analysis methodologies. This vegetation mapping approach involves the following procedures:

1) correcting and normalizing the satellite imagery;
2) processing the imagery using a conventional software package;
3) clustering the images into polygons;
4) correlating the ground-truthed data with the identified polygons; and
5) statistically determining land cover classes.

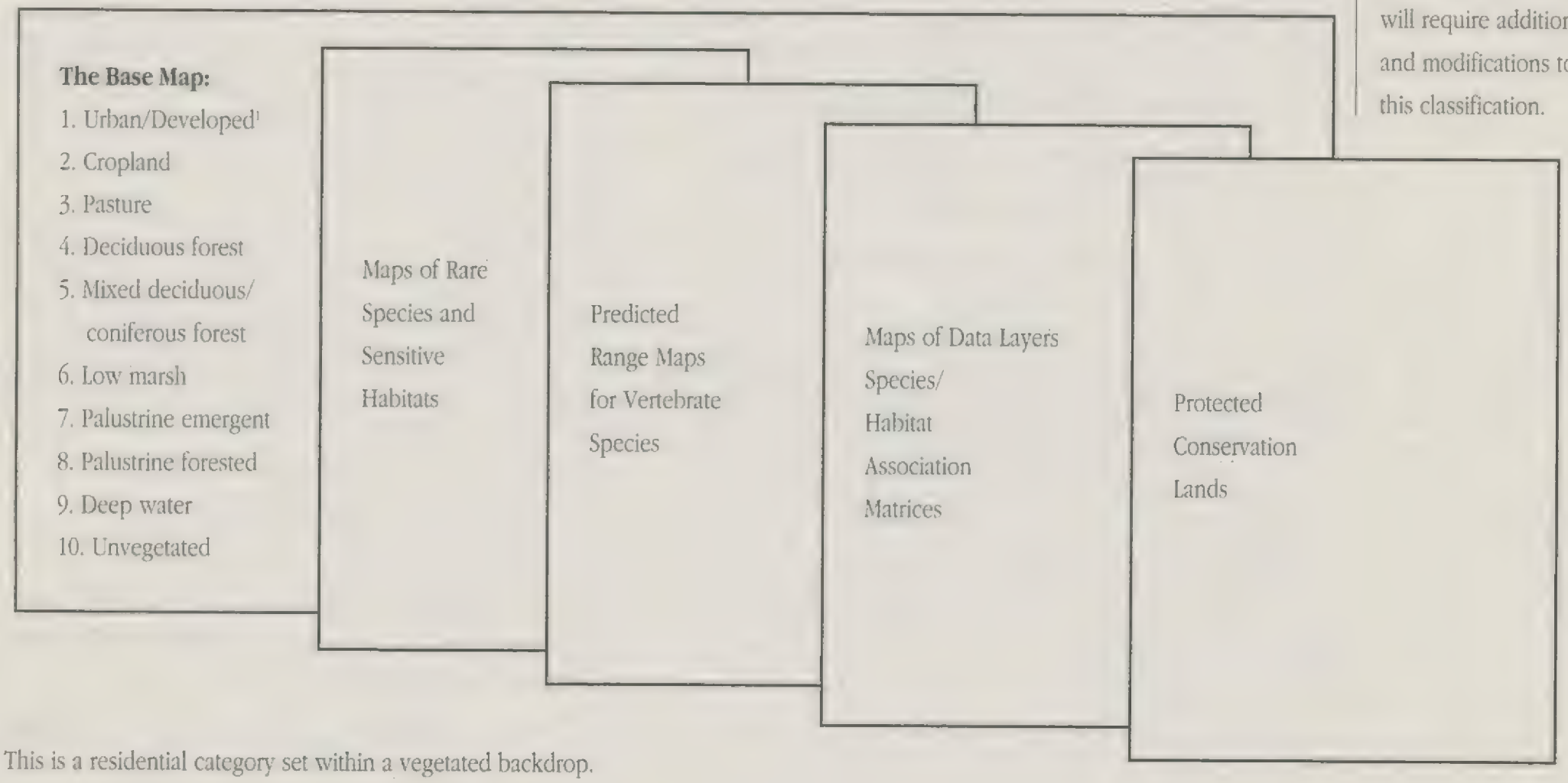
Phase 1

New England Gap Analysis is being implemented in two phases. In the first phase a rudimentary Gap analysis is performed using a "coarse" resolution vegetation map and includes the elements presented in Figure 1. The number of vegetation types distinguished in this phase is limited, and therefore, only an elementary identification of protection levels for species and habitats across the entire New England region can be produced.

In Phase 1 we chose a 1:100,000 scale quad in central/western Massachusetts to test our approach to satellite imagery interpretation and land cover classification. There was much variance in the recorded TM data for the various forest types in New England. The use of compatible imagery scenes from only one season and the lack of available comprehensive ground-truthed vegetation data for the entire New England region are among the central factors that limit the application of this technology. Therefore in Phase 1 we are currently producing a vegetation map for the entire region with only a maximum of three forest classes.

Using this Phase 1 approach, we identified only limited applications for TM imagery in New England. However, in some subregions it may be possible to create a slightly greater number of forest classes if adequate field survey data are available.

Figure 1 shows the elements of the New England Gap Analysis Program being used to assess the conservation status of biodiversity in New England. This is a preliminary base map land-cover classification developed for the southern Connecticut area bordering on Long Island Sound and still requires translation into the natural terrestrial cover classification used by the National Gap Analysis Program (Jennings 1993). Different scenes in the New England region will require additions and modifications to this classification.



1 This is a residential category set within a vegetated backdrop.

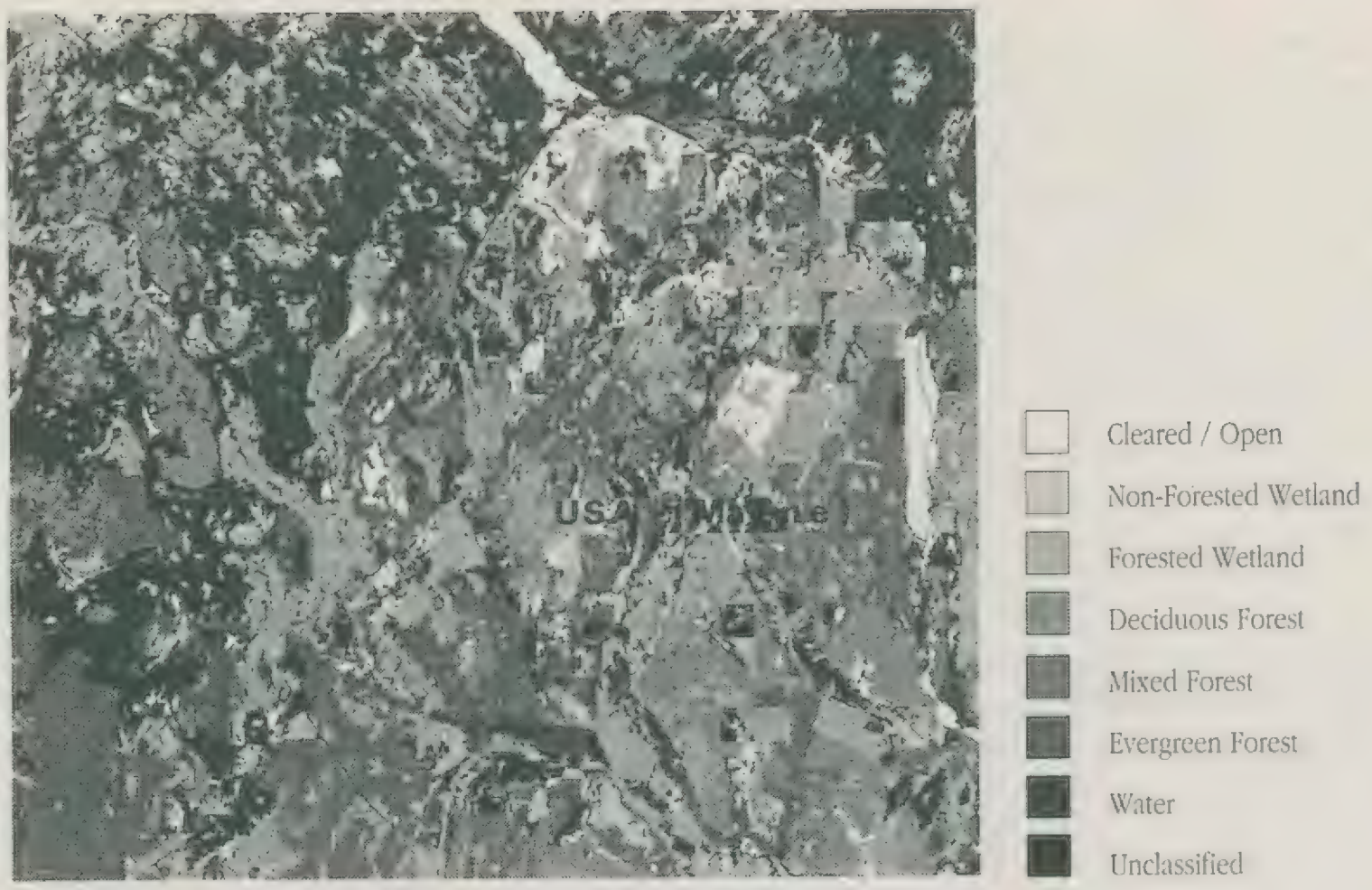


Figure 2. A land cover map that includes a portion of the 1:100,000 Allagash quadrangle in northern Maine. This map is a subset of the Allagash quadrangle defined by northeast coordinates of 69°W47°37′ N and southwest coordinates of 70°W47°N. This serves as an example of the land cover classification being used in the New England Gap Analysis project.

Phase 2

In Phase 2, a higher resolution analysis will be performed on a pilot study area within the region. Using a variety of modern technologies, we should be better able to classify the New England heterogeneous vegetative communities for Gap analysis. This approach will also involve the use of several additional data sources to improve the resolution precision.

One or two additional TM scenes from alternative dates will be utilized in this phase. The comparison of additional TM data should permit us to derive a significantly higher vegetation resolution from the TM imagery. This should help to produce a vegetation classification for this area that contains significantly more than the three vegetation categories that we are currently able to provide for the whole six state region.

Advanced videography in the pilot study area should permit the precise, high resolution ground-truthing of vegetated areas across New England with a minimum of time and effort.

Finally, the study area will include pre-existing ancillary data that are not available for the entire New England region. The study area in New England will have more detailed data both for vegetation and for species. This will permit us to demonstrate the full power of the Gap analysis approach for identifying vegetation types, species assemblages, and their degree of protection for conservation planning.

CONCLUSION

Gap analysis is a means of efficiently assessing the status of biodiversity resources based upon real world, land cover patterns. Effective approaches and techniques are currently being developed and tested in New England as a means for assessing biodiversity resources in the heterogeneous habitats of the northeastern U.S.

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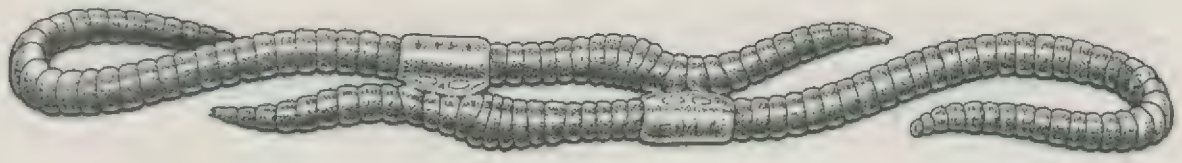

Earthworms of the world

It took the genius of Charles Darwin in the 1800s to appreciate the key role of the lowly earthworm in adding humus to and turning over the soil—up to 40 tons of soil per hectare per year! Dr. Reynolds, world oligochaete expert, summarizes the latest discoveries on earthworms, the number of species, their diversity, world centres of richness, their habitat requirements, and what valuable roles earthworms play in maintaining healthy soil. Find out what pesticides are lethal to worms and which species are most useful in composting in warm and cool climes.

[D.E.M.]

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INTRODUCTION

If considered globally, there is tremendous diversity in terrestrial earthworms. When most people look at earthworms they believe that there are large or small ones and reddish-brown or pale ones. According to the most recent index (Reynolds and Cook, 1993), as of 31 December 1992, there are 7,254 members of the Oligochaeta of which about half (3,627) are terrestrial earthworms. How many more species are there? After Linneaus described the first species (*Lumbricus terrestris*) in 1758, an average of 26 new species per year were described for the next 220 years. And during the past 11 years, there have been an average of 136 new species per year described! At the current rate, the number of known species of the Oligochaeta will double by the year 2045. The "hot spots," or areas where the greatest numbers of new species have been described, are Mexico, Central and South America, including the Caribbean.

What are the Oligochaeta? They are a class of the Phylum Annelida, which are defined as segmented worms, with identical right and left sides (bilaterally symmetrical), with an external gland (clitellum; see Figure 3 for body parts) for producing the egg case (cocoon), where both sexes are in the same individual (hermaphroditic), with a sensory lobe in front of the mouth (prostomium), where the mouth is at the front end and the anus is at the tail end of the animal, with no limbs but a small number of bristles (setae) on each segment (Reynolds and Cook, 1977). The earthworms have essentially a "tube within a tube" body plan. Close relatives to the oligochaetes found in the other classes of the Annelida include polychaetes or marine worms, leeches, and three other lesser known worm groups that have relatively few species.

Terrestrial oligochaete's vary greatly in size. Some *Dichogaster* species are less than 20 mm long (Reynolds, 1994a), while other tropical species are more than 1,200 mm in length (*Glossoscolex* spp.) (Reynolds, 1976). In Australia, some of the largest earthworms in the world reach almost 3,000 mm in length. In North America, the largest earthworm measures 300-400 mm in length.

Some earthworms are brilliantly iridescent and can jump 30 cm in the air.

Besides size, colour in earthworms exhibits tremendous diversity when viewed globally. In North America we generally see earthworms in limited shades of red, yellow, green, brown, purple, white, or grey. In the Oriental family Megascolecidae, however, the pheretimoid earthworms are quite striking. Their brilliant iridescent colours of orange, green, blue, or purple, together with their snake-like movement and ability to jump sometimes more than 30 cm into the air, often gives the casual observer the indication that these animals are small snakes rather than earthworms. In recent years, some of these species have become a significant part of the earthworm fauna in some of the southern United States.

GLOBAL DISTRIBUTION

Earthworms are no different than plants and other animals in that each continent (except Antarctica) has its own distinct or indigenous species, plus others which have been introduced by humans deliberately or by accident. Many of the species and even some of the families of earthworms have been known from only a very few individuals and species. There are currently 18 families of terrestrial earthworms; of these only about a dozen exhibit any sort of widespread distribution (Reynolds, 1994b). In the world map shown in Figure 1, the distribution of the families is illustrated. The numbers in parentheses in the upcoming list following their name represent those families in Figure 1.

The zoogeographical regions where the earthworm families are believed to have originated are listed below, as well as the other continents to which they have been transported (Reynolds, 1994b; Sims, 1980).

Australian = Australia, Tasmania, New Guinea and some smaller islands of the Malayan Archipelago.

Native: Acanthodrilidae (1), Octochaetidae (6)

Exotic: Lumbricidae (2), Megascolecidae (3)

Ethiopian = Africa south of the Sahara Desert and Atlas Mountains, and the southern corner of Arabia.

Native: Eudrilidae (4), Microchaetidae (5), Octochaetidae (6)

Exotic: Lumbricidae (2), Megascolecidae (3), Moniligastridae (7)

Nearctic = Canada, United States, Greenland, and northern Mexico.

Native: Acanthodrilidae (1), Komarekionidae (8), Lutodrilidae (9), Sparganophilidae (10)

Exotic: Eudrilidae (4), Glossoscolecidae (11), Lumbricidae (2), Megascolecidae (3), Octochaetidae (6), Ocnerodrilidae (12)

Neotropical = South America, Central America, most of Mexico, the West Indies and New Zealand.

Native: Acanthodrilidae (1), Almidae (13), Glossoscolecidae (11), Ocnerodrilidae (12)

Exotic: Lumbricidae (2), Megascolecidae (3)

Oriental = India, Indochina, south China, Malaya including the westerly islands of the Malayan Archipelago.

Native: Megascolecidae (3), Moniligastridae (7), Octochaetidae (6)

Exotic: Almidae (13), Eudrilidae (4), Lumbricidae (2)

Palearctic = Europe to the Pacific Ocean, Africa north of the Sahara Desert, and Asia north of the Himalaya Mountains.

Native: Almidae (13), Diporochaetidae (14), Hormogastridae (15), Lumbricidae (2)

Exotic: Megascolecidae (3), Sparganophilidae (10)

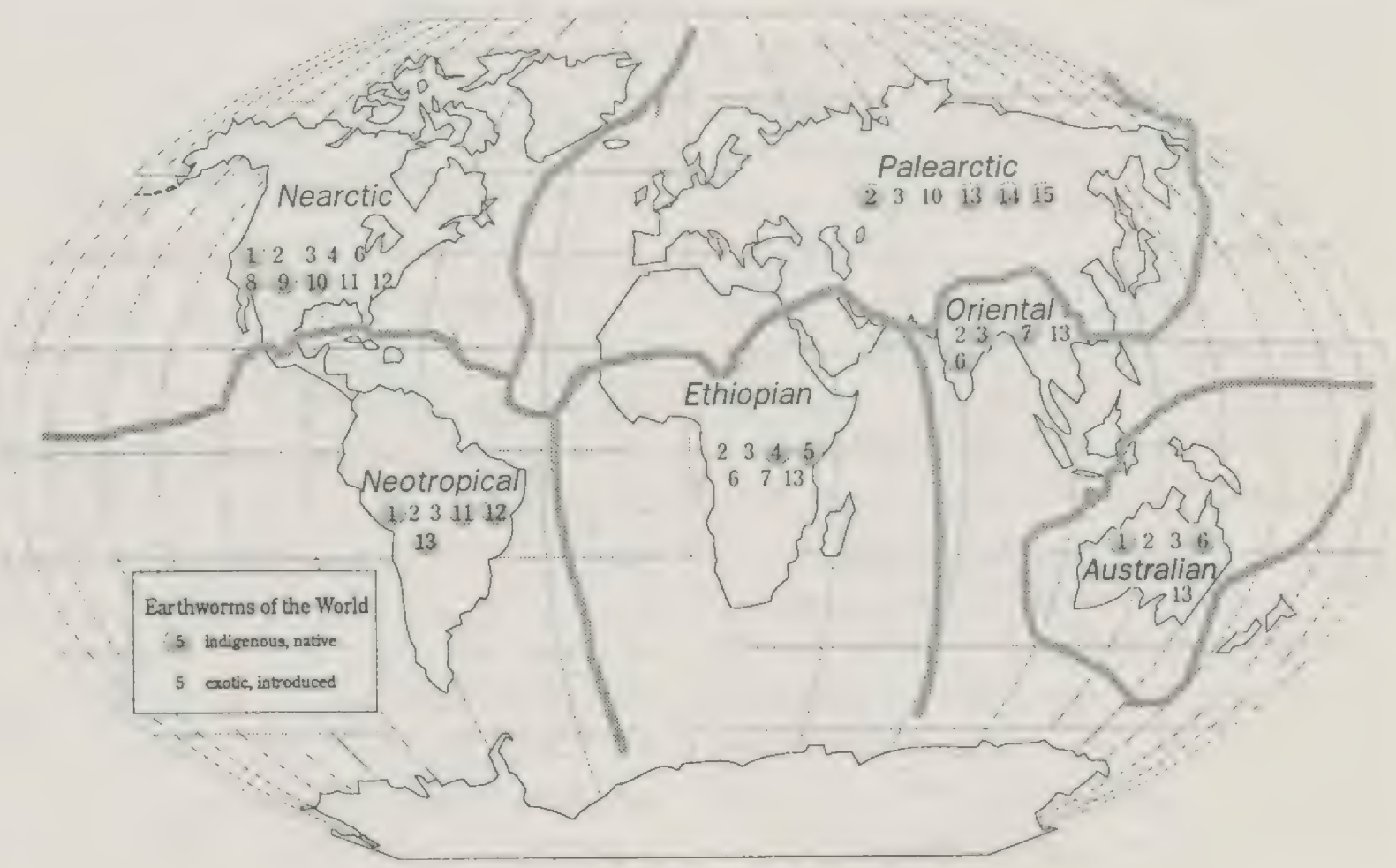


Figure 1
The origin and dispersal of the major terrestrial earthworm families.

Map courtesy of John W. Reynolds

BARRIERS TO MIGRATION (DISPERSAL) & HABITAT REQUIREMENTS

From the previous discussion and Figure 1, it is obvious that earthworms are distributed around the world in their native habitats and, in the case of some families, to new areas where they have been transported by humans and other animals. Earthworms' ability to migrate any distance by their own means is limited by several environmental requirements for their successful habitats. These are animals which have no limbs, no eyes, and require a moist skin in order to breathe (Reynolds, 1973).

HABITAT REQUIREMENTS

The following conditions are required in a habitat in order for earthworms to survive:

- *Adequate and suitable food supplies*
  As feeders of dead or decaying plant remains, and sometimes dead animal remains, earthworms remain close to their food source.

- *Adequate moisture*
  Because earthworms breathe through their outer skin layer, a moist habitat is essential to allow respiration.

- *Adequate dissolved oxygen*
  Earthworms are air-breathing animals, and therefore, dissolved oxygen in their habitat is essential for respiration. Earthworms have lived submerged for up to a year in oxygen-rich environments.

- *Protection from light*
  Ultra-violet radiation is lethal to earthworms in a very short time period.

- *Suitable pH*
  Some acidity is not a problem, but it is difficult for the earthworms to extract nutrients from a food source under very acidic (high pH) or very basic (low pH) conditions. In these two situations, the necessary chemical reactions that permit digestion to occur are inhibited. The presence of calciferous glands help buffer reasonable acidic conditions so that some species can live under conditions of pH 2.8 - 4.5. Most species are found in habitats where the pH is 4.5 - 7.5 and none have been found where the pH exceed 9.

- *Absence of toxic substances*
  Habitats with high concentrations of various salts do not contain earthworms. Many pesticides have little or no effect on earthworms. In fact, they can survive under conditions where the concentrations are 20 times the lethal limit for other species. There has been much debate between scientists and organic gardeners about the effects of pesticides on earthworms. A recent general summary of some common pesticides follows (Reynolds, 1992):

  1) Azinphosmethyl, diazinon, malathion, and menazon appear to have no effect on earthworms.
  2) In normal doses, Aldrin, BHC, carbofuran, chlorfenvinphos, DDT, Dieldrin, disulfoton, Dyfonate, Endrin, fenitrothion, Teladrin, and trichlorphon have very little effect on earthworms.
  3) In large doses, Aldicarb, carbofuran, and Parathion are moderately toxic.
  4) Carbaryl, Chlordane, Heptachlor, and Phorate are toxic to earthworms.
  5) There are also some substances, causing osmotic or water balance responses, that are lethal to earthworms even in small doses.

- *Suitable temperatures*
  The optimal temperature range for the development of most earthworm species is 12°- 20°C. Certain species, such as *Eisenia foetida*, have a much higher optimal developmental temperature, and hence are very successful when used for vermicomposting in North America, Australia, Europe and South America (Reynolds & Eggen, 1993). In Africa, *Eudrilus eugeniae* is used for this purpose, while in India and its neighbours *Dichogaster bolaui* and *Perionyx excavatus* are employed in vermicomposting (Dash & Senapati, 1986). The major advantage of worm composting over conventional methods is speed or turnover rate. When the proper earthworm species are used, the time required for decomposition can be reduced to a third.

BARRIERS TO MIGRATION

The barriers to migration are tied closely to the habitat requirements discussed above:

- *Mountain ranges*
  The shallow soil or bare rock of mountain habitats means earthworms are exposed to unfavourable conditions of drying, ultra-violet radiation, reduced oxygen, and limited suitable food sources.

- *Deserts*
  Limited food sources and a severe reduction in available moisture in the desert environment mean earthworms may become inactive or aestivate.

- *Salt water*
  Most earthworms can't survive in salt water or soils saturated with salt water. *Pontoscolex corethrurus*, a tropical species, which has invaded the southern tip of Florida from the Neotropical area, seems to be able to tolerate a certain level of brackish conditions.

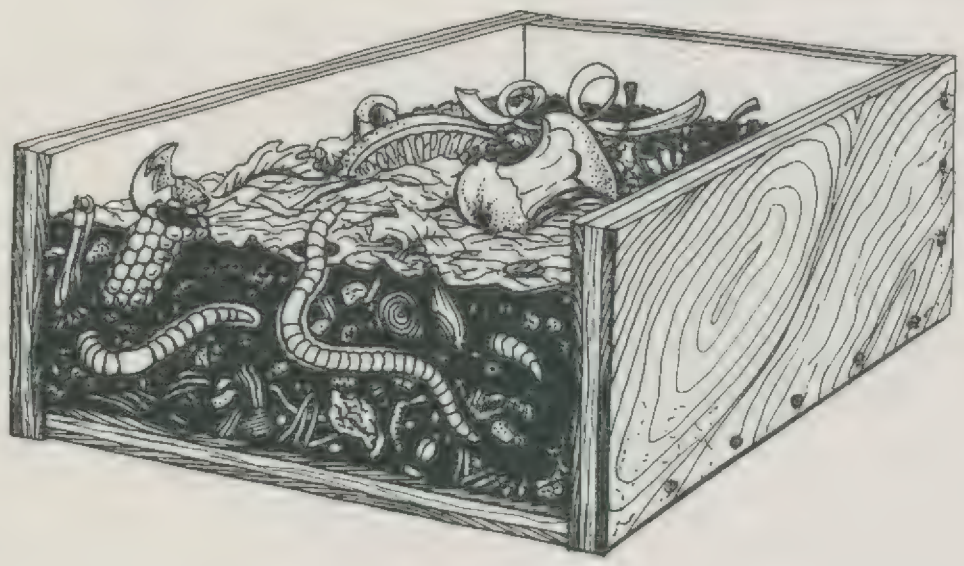
- *Climate*
  Extremely hot dry areas will restrict earthworms; under unfavourable climatic conditions earthworms go into quiescent periods, see *Deserts* and *Ice/snow*.

- *Ice or snow areas*
  Prolonged periods of ice or snow may restrict available food sources, available moisture, and the earthworms may become inactive or hibernate.

- *Competition*
  New species invading an area may not be able to adapt to native species already in place, or conversely may adapt better to the habitat. An example is found in North America, where native species of *Bimastos* utilize the under bark habitat of decaying trees below the glacial boundary. North of the glacial boundary, these habitats are exploited by *Dendrodrilus rubidus* in the absence of *Bimastos* spp. South of the glacial boundary, *Dd. rubidus*, when present, is forced out into the soil surrounding these decaying trees.

- *Parasites or predators*
  There are a large number of organisms that prey on earthworms and restrict their movement and/or establishment in a habitat. These include various insects (*Pollenia rudis*), mites (*Uropoda agitans*), certain centipedes, snakes, salamanders, frogs, certain birds (robins, woodcock), and small mammals (moles, voles, shrews).

For details on vermicomposting, see page 49



HABITATS

Earthworms are found in various horizons of the soil, on top of the soil in the surface litter, in rotting logs, up in the axils of tree branches, and in moist soil surrounding natural freshwater bodies (lakes, streams, rivers, springs, etc.).

Some worms live 10 metres above the ground in trees.

Certain species live only in the top few centimetres of the soil, while others burrow in the deeper depths of the subsoil. Some of these deep soil dwellers come to the surface to feed on the litter. Others remain in the litter as long as sufficient moisture is present. Those that require a soft moist mud habitat are rarely found very far from the shore-line. Those that live high up in the tree axils (10 metres or more above the soil) are restricted to the tropical habitats of the world. In Figure 2, there is an example of the positioning of different species, which might be used by the American woodcock (*Philohela minor*), in the same habitat (Reynolds, 1977).

Earthworms are invaluable. They help decompose organic matter, increase the capacity of the soil, neutralize acid soil, aerate the soil, and help water penetrate the soil vertically and horizontally.

FUNCTIONS OF EARTHWORMS IN THE SOIL

Although earthworms may be found in the soil and adjacent habitats, there is considerable diversity in their activities and functions in these habitats. The following list of annotated functions are the main ones:

- *Organic matter decomposition*
  Some species (e.g. *Lumbricus terrestris*) actually take the leaves and surface debris and physically or mechanically break them apart, which enables microorganisms to complete the decomposition. Other species, which are "soil eaters," chemically alter the organic matter as it passes through their intestines. The breakdown and incorporation of organic matter into the soil increases its water-holding capacity for use by other plants and animals.

- *Soil neutralization*
  As soil is passed through the intestines of the earthworms, their calciferous glands secrete calcium compounds that raise the pH of the material nearer to

the neutral state. The less acidic the soil, the more easily chemical reactions take place. These reactions are necessary for most aspects of plant and animal life in the soil, e.g. incorporation of nutrients into plant roots.

- *Soil aggregation*

  As the small soil particles pass through the earthworms' intestines, they are bound together with a mucus substance into larger masses of particles. This improves the structure of the soil, as well as incorporating the decomposed organic matter into these masses. These larger masses or aggregates are frequently referred to as "castings."

- *Soil aeration*

  By eating their way through the soils and producing larger aggregates, channels develop in the upper soil horizons, which permits the increased movement of air, specifically oxygen, into the soil. The presence of adequate oxygen in the upper soil layers is essential for the growth and development of all aerobic plants and animals.

- *Infiltration of water into the soil*

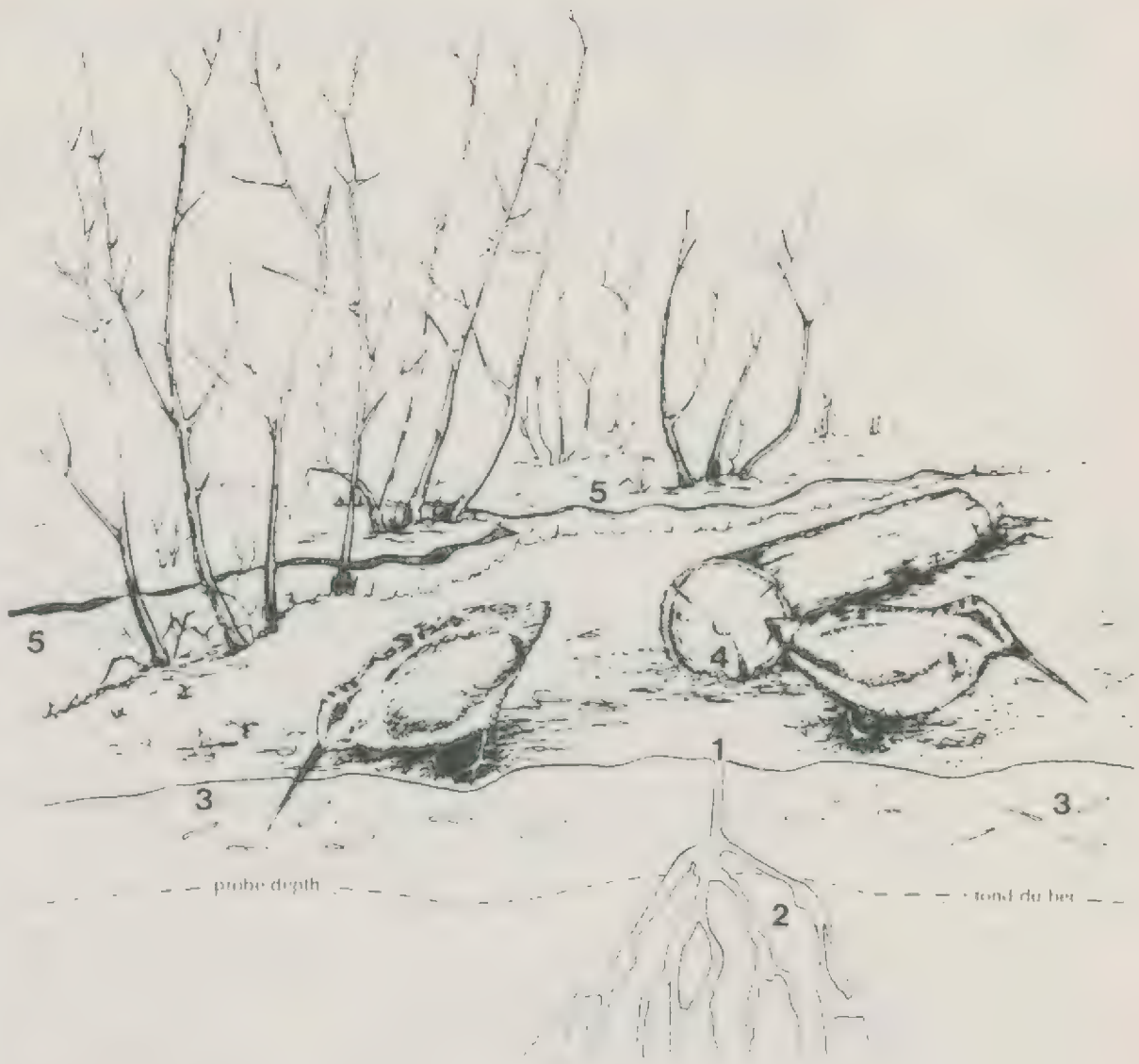
  The channelling and aggregate production by earthworms increases the ability of water to penetrate the soil surface into the upper layer. Infiltration is one of two important aspects of soil water movement.

- *Percolation of water within the soil*

  The second aspect is percolation, the movement of water within the soil. The activity of earthworms increases the ability of soil water to move down and throughout the soil horizons. The availability of soil water at the level of the plant roots is important for plant growth and development.

- *Soil turnover*

  Soil turnover is the amount of soil that passes through the body of an earthworm in a certain time period. Experiments in North America and Europe have measured this activity and found it to be 85 - 120 mg of soil per day per worm. All habitat factors being equal, the range is primarily due to the varying sizes of different earthworm species, in that the amount of soil passing through an earthworm's digestive system per day represents approximately 20 - 30% of its live body weight.

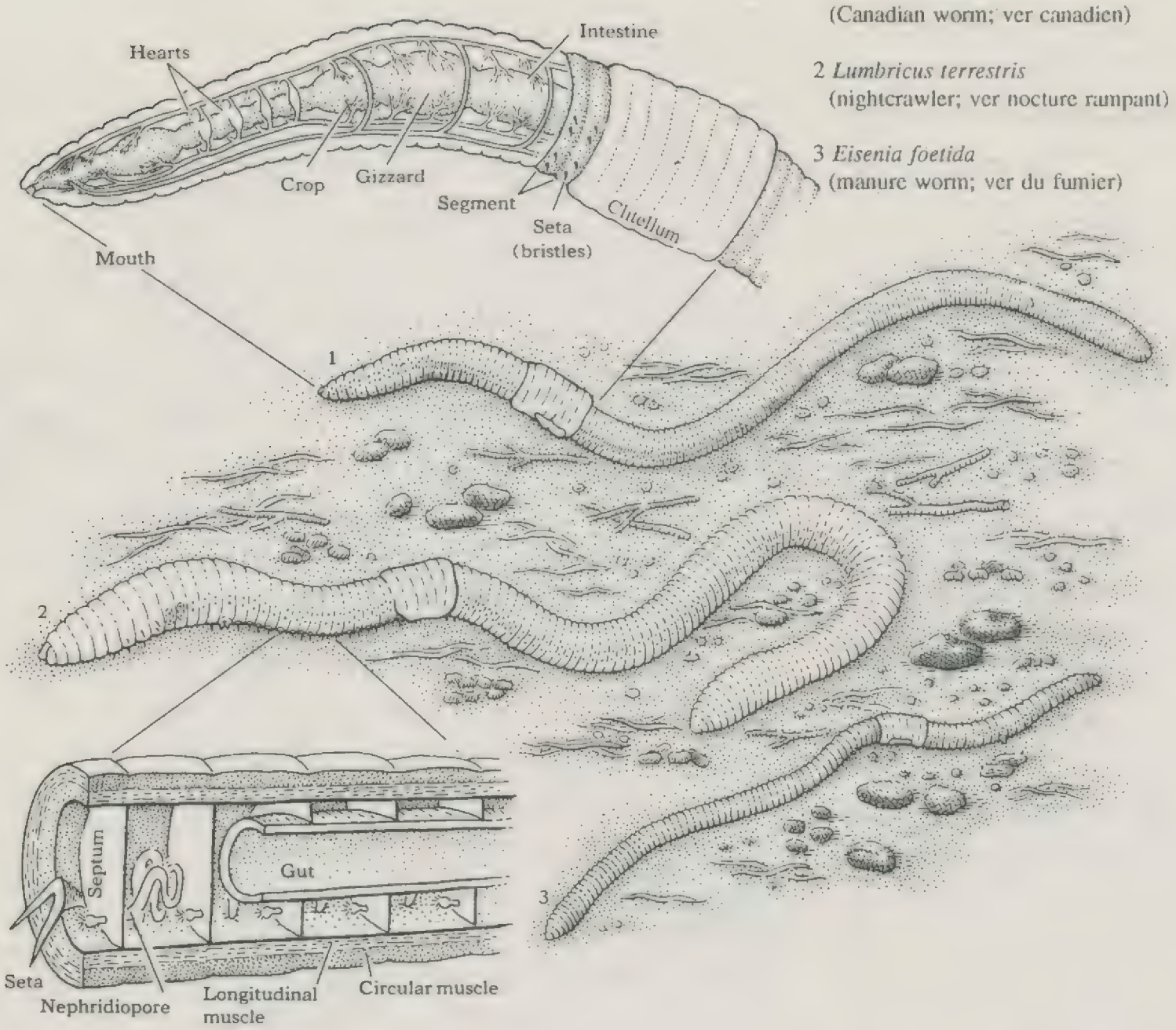


SUMMARY

The earthworms of the world exhibit considerable biodiversity in a number of areas. Morphologically, they vary in size and colour. Although restricted in migratory pattern by numerous barriers, each continent has a distinct earthworm fauna and a number of introduced species. A variety of habitats are used by earthworms, and within each habitat these animals provide a variety of functions. In many parts of the world, new species are being discovered each year; the pace is limited by the few specialists available.

There have never been a great number of oligochaetologists (earthworm specialists) at any given time. Currently, there are no more than a dozen full-time specialists in the world. In order for our knowledge to continue to expand and keep up with the potentially large numbers of new species to be described, there is a tremendous need for additional specialists to be trained immediately. As well, every year many potential new species may be lost forever, *before* they have been recorded, due to the widespread habitat destruction by humans.

Figure 2.
Earthworm species' habitats and their availability to the American woodcock *(Philohela minor)* in northern North America.
1 - *Lumbricus terrestris* nocturnal habitat;
2 - *L. terrestris* diurnal habitat;
3 - surface soil species which could be available to woodcock;
4 - corticole species - *Dendrodrilus rubidus* - generally unavailable to woodcock and;
5 - limicolous species - *Eiseniella tetraedra* - possibly available to woodcock, if worm present. (after Reynolds, 1977)



1 *Aporrectodea tuberculata*
(Canadian worm; ver canadien)

2 *Lumbricus terrestris*
(nightcrawler; ver nocture rampant)

3 *Eisenia foetida*
(manure worm; ver du fumier)

Figure 3. Some morphological characteristics of commonly occurring earthworms in North American (after Reynolds, 1978)

ACKNOWLEDGEMENTS

I would like to express my sincere appreciation to Profs. Sue Mantle and Mary Ellen Gray of Sir Sandford Fleming College for their assistance with the figures in this text.

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AN ALTERNATIVE VIEW:

Forest protection in the Philippines

The week before this manuscript was received the editor was being interviewed by a Californian TV script writer about coral reefs in the Philippines. She had recently visited Palawan, the southwestern island province of the Philippines. While she was there, a forest guard had seized a chain saw that was being illegally used. Later an armed military person, armed with an automatic rifle, reappropriated the saw and claimed it was his. Despite the vital need, protecting the few remaining forests in the Philippines is obviously a risky job!

[D.E.M.]

Caballo and Hari ng mga Bubule
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CANADA

In 1992, in a *Canadian Biodiversity* article, Aris Ilagan painted an optimistic, if somewhat stark, picture of the current situation of forest protection in the Philippines. Ilagan contended that non-government organizations (NGOs) have been able to take up the slack left by the inadequate governmental efforts at reforestation to a certain extent.

Over the past two years, we have spent eleven months in the Philippines involved in various capacities in a vertebrate biodiversity and inventory survey of different islands. These surveys have attempted to assess the remaining biodiversity (some undiscovered) of tetrapods in as remote (and, by inference, pristine) a setting as possible. The very nature of these studies has also enabled an assessment of the status of forest cover and condition in the areas visited as part of the surveys. The sad reality is that forests of the Philippines are in much worse condition than depicted by Ilagan (1992).

Based on satellite surveys (Swedish Space Corporation, 1988), current estimates of remaining Philippine virgin dipterocarp forests, which are lowland closed canopy forests, are closer to 8% than to Ilagan's stated figure of 25%. Originally, 90% of the Philippines were covered by forest! (Anonymous 1944; Dickinson and Kennedy 1992; Whitford 1911).

The loss of particular types of forest are even more alarming. For example, estimates of the original extent of Molave (*Vitex parviflora*) forest have been put at about 2% of total forest cover (Dickinson and Kennedy 1991). Currently, however, there appears to be no Molave forest left. In May and June 1993, there was a 50,000 peso award (equivalent to about US$2,000) offered in southern Mindanao for the location of any Molave tree. Such a sum represents many times the annual income of any person liable to encounter a Molave tree in the course of routine work, but none of the woodsmen we spoke to had seen Molave trees recently. This reward was not offered by governmental organizations or departments, such as the Philippine Department of the Environment and National Resources (DENR), but rather by local logging companies. The reward offered was for the subsequent consumptive use and immediate short term financial gain of the Molave tree rather than for seed harvesting.

The dire environmental situation exemplified above is exacerbated by pressures from the fast growing population, inequitable land distribution, a faltering economy, poor development policies, and

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Figure 1. The change in forest cover (darkened areas) in the Philippines is shown here. On the left, a map prepared for the *Census Bureau* of the United States shows the forest cover in 1903; the map on the right shows the forest cover round 1990. Current estimates place the remaining all intact forest cover in the Philippines (including the different types of rain- and monsoon forests) at about 8-10% of the land area, down from 90-95% ninety years ago.

acute debt (Myers 1988; Goodman and Gonzales 1990). Reliable estimates of forest cover still are unavailable, but a preliminary assessment may be drawn from a number of sources. Figure 1 shows a map of the forest cover as estimated around the turn of this century (Ahern 1905) compared to more recent assessments of forest cover (compiled from: Forest Management Bureau 1988; Swedish Space Corporation 1988; Cox 1991; Dickinson et al 1991; Lean and Hinrichsen 1992). The reduction in forested area is quite evident. Indeed, Cox (1991) tabulates the extent of intact forest as 10.1% of the land area, while adding that there still exists some 22.1% of degraded forest of various natures.

There practically are no mangrove or lowland dipterocarp forests left in any of the islands except Palawan, although northeastern coastal Luzon is said to still contain some extensive tracts of lowland dipterocarp forest. In terms of percentage of land area covered, mangrove forests are down to less than 0.1% from about 2.1% in 1932, and lowland forests are down to 4.6% from about 75% in 1932! (figures from Cox 1991; Dickinson and Kennedy 1991). Thus, when any estimate of remaining forest cover is stated, the estimate basically refers to fairly inaccessible stands of montane and upper montane ("mossy") forest. This means more than mere loss of forest cover and resulting immediate impact to humans (i.e., the massive flood at Ormoc in November 1991).

Numerous vertebrate species in the Philippines are limited to individual islands or island groups, and, within said groups, to specific types of habitats or mountain tops (Inger 1954; Heaney et al 1987; 1991; Ruedas et al., 1994). As an unfortunate consequence of the ongoing forest clearing documented above, the trapping of rodents throughout much of the Philippine lowlands results in an almost invariant mixture of six introduced species associated with humans: *Rattus rattus, R. exulans, R. argentiventer, R. norvegicus, R. nitidus* and *Mus musculus* predicted by Musser (1977). In addition the Asiatic House Shrew (*Suncus murinus*), another introduced species, is taking over much of the lowlands. On some islands, such as Panay, we have found this species even in mossy forest at an elevation of 1,760 m. Similarly, the giant cane toad, *Bufo marinus*, yet another exotic (New World), is seen in most habitats of the Philippines. This is disturbing, to say the least. Ideally, the trapping should have resulted in exciting new finds, or confirmation of old records of presence.

We concur with Ilagan (1992) that current reforestation efforts are inadequate. However, we will go one step beyond stating that the inadequacy is based merely on rate of reforestation. It is an uncontested fact that the rate of *re*forestation in the Philippines is much too slow, but even more distressing is the *type* of reforestation being undertaken. Formerly heterogeneous stands of lowland, primarily dipterocarp, forest are being replaced by monoculture stands of relatively fast-growing South American Mahogany (*Sweetenia macrophylla*), and by secondary forest indicator species such as the Australian *Acacia mangyum.*

Is the problem one merely of rapacious loggers? Yes—and no. Often tribal communities are more concerned merely with day to day survival than the long term interests of the community. Thinking with a long term perspective is a luxury that can be afforded only after survival is assured. Thus, if particular tribal groups are given stewardship of their forest, it means nothing more than business as usual with no change in hunting patterns. In fact, we repeatedly observed poaching of CITES listed birds—hornbills, parrots, and many others—and mammals—most obviously, deer, wild pigs, and macaques, as well as others. The one thing that does change is the ease of access to the forests. Previously, loggers could come in only with the authorization of the DENR or other regional environmental authorities. Now they need only the approval of local chieftains. Such approval is easily secured with small sums of money.

As an example, although the T'boli tribespeople of Sarangani and Cotabato provinces (Mindanao Island) nominally control their territory, extensive logging and mining operations are under way in their tribal lands. When we visited these areas in April and May 1993, the mining operation was in the exploratory phase. It is, therefore, difficult to gauge the potential impact on the community.

The logging operation clearly was detrimental. Ilagan (1992) mentions that the illegal ventures using "sophisticated timber-cutting" equipment are the culprits. Nothing could be farther from the truth. Insofar as the logging operations that we have witnessed, it is the *lack* of sophisticated techniques that causes the damage. Logging operations rely on nothing but a chain saw and World War II surplus military vehicles. In order to gain access to a single, particularly lucrative tree, an entire area of forest will be laid waste. When we attended the cutting of one tree in the hopes of sampling the fauna in the crown, we actually had to move five times during the cutting process, because the chain saw operator did not know where the tree would fall. In a similar vein, when all logging within 20 m of waterways is purportedly prohibited, cut logs covered over streams.

The clear cuts resulting from this method of logging are invariably strewn with logs of secondary commercial value that are left to rot. Apparently they are not worth removing. As a result of logging near watersheds, the common stream frog, *Rana signata grandocula (sic.)*, seems to have been extirpated downstream from cutting areas, where the streams were red from topsoil run-off. Similarly, edible freshwater shrimp are almost impossible to secure downstream of logging operations.

To a certain extent, NGOs are trying to take up the slack where the government's work stops. Most of these efforts are inadequate, or worse still, ill conceived. One archetypal example of the positive work of NGOs is the stewardship agreement obtained by the Mangyan community over their forest (Ilagan 1992). Again, however, there is a disparity between handing over stewardship and the economic realities of the native peoples of the area. The Mangyan tribespeople of Mindoro are one of the poorest communities of the Philippines. When we visited Mt. Halcon Highlands (part of the Mangyan Heritage area in northern Mindoro) in May and June of 1992, *all* logging was prohibited. Nevertheless, extensive logging was under way up to an elevation of about 900 m. In fact, the sound of chain saws

would cease abruptly as we approached and would resume after we were past, indicating a look-out system. Local DENR officials claimed to be powerless in the face of staff shortages. The Mangyans themselves were adamantly opposed to logging, as they have witnessed detrimental effects already, specifically the silting of streams. But the short-term economic reality is that individuals must survive, and logging does provide a steady source of revenue.

Our last commentary will be on the sources of illegal logging in the Philippines. Ilagan (1992) reported that illegal logging primarily has been linked to military personnel and police, as well as government officials (usually of the DENR) who are "closer to the action." The larger problems are caused by companies that have a legal concession, but carry out logging in an illegal manner. For example, if permission is granted to carry out selective logging, that is one thing; however, if there is complicity with local DENR officials, it is very easy for the company to carry out clear-cutting and cutting in watershed areas (as was the case in the T'boli domains). Once the wood leaves the area with official papers, it becomes legal.

Problems are often compounded when the logging operations are under the direct or indirect control of former speaker of the House and presidential candidate Ramon Mitra. Operations in Mindanao are variously controlled by the Mayor of General Santos City (southern Mindanao) or former members of the Philippine Senate (Surigao area, northern Mindanao). Often non-compliance with such individuals is fatal. In 1991, the director of the Philippine National Botanic Garden was gunned down by unidentified assassins after attempting to block illegal logging in the Quezon Real Province reserve. The culprits are still at large.

It is easy to exemplify the complicity between DENR local officials and logging companies. One area DENR office that we visited had guest quarters built with supplies and materials "donated" by the local area logging company, as well as direct radio communication with the company headquarters. Officials from this office kept macaques (*Macaca fascicularis* sensu lato, a CITES listed species) as pets, regularly ate deer, wild boar, and civets for meals, and were observed to partake of sea turtle on one occasion. DENR officials in a different area had direct communication with another logging company, this time via cellular telephone; the same logging company supplied chauffeured vehicles to DENR officials. Finally, another team of scientists, who were engaged in similar work to ours, found that illegal logging was going on in Mt. Kitanglad (Bukidnon Province, Mindanao Island) under direct supervision of local DENR and police officials.

The above vignettes point to a much more alarming perspective of the forest protection and loss situation in the Philippines than was painted by Ilagan (1992). Ultimately the problem stems from a population issue, which results in financial and education shortages for the majority of the people of the Philippines. If nothing is done to stem the ever increasing population of the Philippines (1920's 10 million; 1983 52 million; 1993 about 73 million, including 8 to 10 million in Manila alone), then the deforestation problem has no solution. Increasing numbers of people need increasing amounts of space and materials to live. Education is also of prime importance, but unfortunately, many of the NGOs are more concerned with educating the wealthy and well to do as a means of obtaining funds, than they are in educating those peoples most affected by the deforestation problem.

Perhaps the Philippine Eagle Foundation (PEF), in Davao City, Mindanao Island, could be taken as a refreshing example of the power of education. Philippine Eagles (*Pithecophaga jefferyi*) only breed in undisturbed primary forest below 1,200 m. Using the link between forest survival and eagle survival as a paradigm, the PEF personnel can go one step further and explicitly point out complex ecological interactions in easily comprehensible terms, including direct effects by people and on people.

Our wish in the foregoing discussion has *not* been to provide a point by point refutation of the salient elements mentioned by Ilagan (1992), nor do we wish for this to degenerate into an emotional battle of opinion and counter opinion. We do wish to point out, however, that we have a strongly differing perspective of forest protection and environmental degradation in the Philippines. In our opinion, only a strongly backed political and financial effort can help maintain, let alone recover, the forested areas of the Philippines. This two-pronged effort would target population growth and education efforts intensively, with a strong emphasis on enforcement of existing environmental laws and the will to oust corrupt officials.

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Philippine tarsier.
Tarsius syrichta

LETTER ON

Logging Clayoquot Sound

December 25, 1993
To Hon. Mike Harcourt, Premier
Province of British Columbia
Parliament Buildings, Victoria, B.C., Canada

Dear Premier Harcourt:

We the undersigned write out of a deep concern for the Earth.

Having recently learned of the intention to log Clayoquot Sound, and while we do not know all the details concerning this, we do feel a duty as citizens of this beleaguered planet to register our protest.

As representatives of the Indigenous Peoples of the Cordilleras in the Philippines, we urge you to hear the voices of those concerned Canadians brave enough to oppose the cutting of trees. We beseech you to heed the murmurings of your own spirit concerning this matter. We implore you to contemplate a future where the wind can no longer play amongst the leaves, and the deer and the eagle are no more.

How sad it is that governments and big business constantly compromise their integrity and disguise their greed in the name of "progress" or "development." What a shame that eyes blinded by dollars see not the beauties of nature, ears deafened by chain saws hear not the warnings from the woods, and hearts hardened by materiality care not for the plight of the creatures destroyed. How utterly sad indeed.

Please hear us; we speak from experience. Most of our forests are gone. Annually our roads and bridges are washed away. There is very little wildlife left, except rats that destroy our crops and mosquitoes that give us malaria. The souls of our children silently cry for the healing energies that trees provide. For the well-being of this planet and for the sake of its children – please hear us.

On behalf of the Indigenous Peoples
of the Northern Philippines, I am

Respectfully yours,
(signed)
Petra Angpao
(Also attached were the signatures of tribal representatives.)

P.O. Box 10222, Broadway Centrum, Quezon City, Philippines

NEWS FLASH!

As this issue of *Global biodiversity* goes to press, newspapers announced that a long term forest plan, strongly supported by the forest industry and environmentalists, was unveiled by Premier Mike Harcourt, 14 April 1994. Under the plan, the industry would pay $2 billion over five years to replant B.C.'s forests and clean up past abuses. Although some jobs would be lost, at least 5,000 more jobs would be created than lost.

Logging companies would be charged a steeper levy to cut trees on Crown land to create a new fund: Forest Renewal B.C. The fund would support silviculture job retraining, environmental protection, assistance to value-added manufacturers, and increased research and development. The B.C. government is to be complimented on its forward-looking plan that may well stand as a model for other governments.

These maps show the extent of old-growth forests on Vancouver Island in 1954 and 1990. Vancouver Island is being rapidly logged. Few of its second-growth forests are mature enough to provide timber, jobs, canopy habitat, or ecological services. Compare this deforestation with that in the Philippines on page 18.

SHARED FARMING -

A boon for biodiversity

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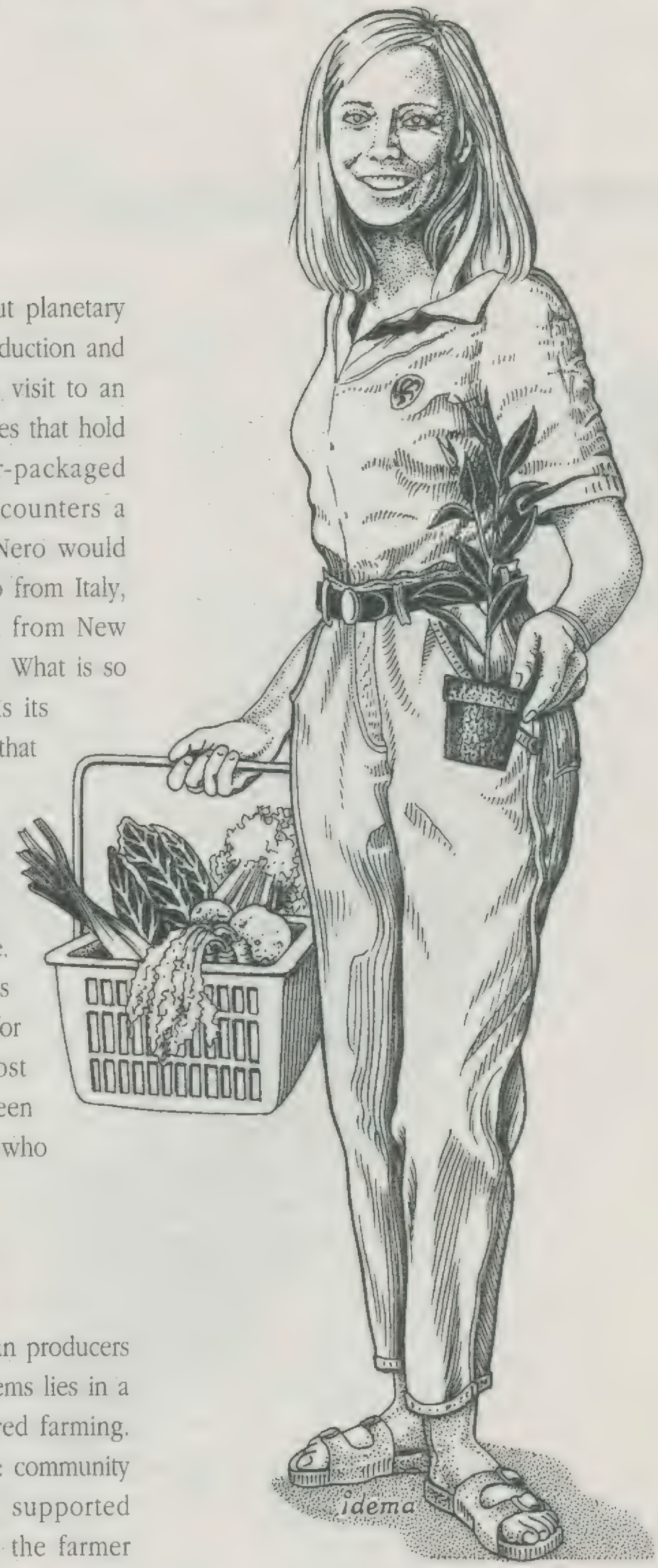


INTRODUCTION

For those people who are concerned about planetary and local biodiversity, the state of food production and distribution is profoundly disheartening. A visit to an average Canadian supermarket reveals shelves that hold thousands of over-processed and over-packaged products. In the produce area, one encounters a cornucopia of fruits and vegetables that Nero would have envied: oranges from Spain, raddichio from Italy, bananas from Central America, kiwi fruit from New Zealand, and yellow peppers from Holland. What is so disturbing about this apparent fecundity is its source: a system of monoculture agriculture that is dependent on synthetic chemicals to control pests and diseases; one that is compromising the genetic and taxonomic diversity of crop species with its insistence on cosmetic uniformity and processing ease. Furthermore, this is a system that has abandoned the idea of local self sufficiency for global economies of scale and has almost severed a once important link—that between the person who grows the food and people who consume it.

WHAT IS SHARED FARMING?

For a small but growing number of Canadian producers and consumers, the solution to these problems lies in a simple, yet effective concept; that of shared farming. There are different labels for the same idea: community shared, consumer shared, or consumer supported agriculture (CSA). The basic idea is that the farmer

receives payment for crops directly from consumers, with both farmers and consumers sharing in the profits (in this case, the crop) or losses. The grower generally delivers produce to the customers. Delivery can be individual or the customers can be organized in groups in which one family agrees to let their garage or driveway serve as a pick-up depot, or who meet in a church parking lot to collect their food. All Canadian CSA arrangements documented thus far involve organic farming only; not all growers have been certified as organic, but the methods are invariably organic. There are CSA arrangements in almost all provinces and the number is growing.

HOW DOES IT AFFECT PEOPLE?

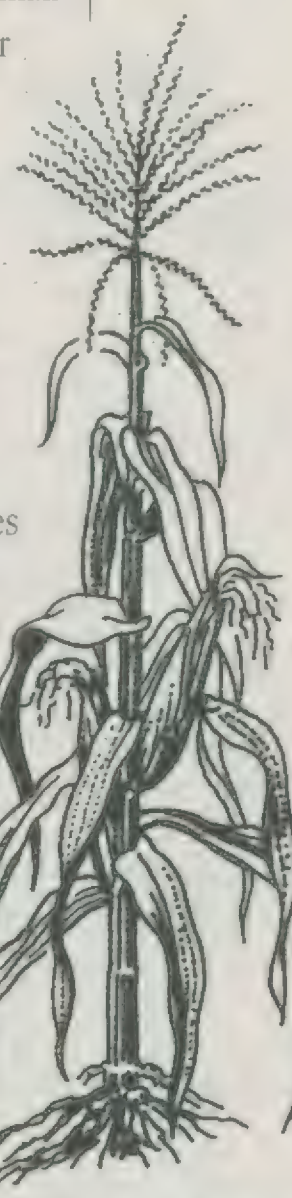
Benefits to farmers can be considerable. Because the needs of the customers are known before planting, they can accurately estimate the kinds and amount of produce they need to deliver. Because they receive pre-payment at a retail price for their produce before planting, they no longer have to rely on banks for short term loans to get them through the growing season. In some shared farming situations, the farmer and consumers own the land and machinery together through a board of directors, thereby spreading the costs and risk much more equitably.

Curiously, this sharing of risk is one of the most important benefits that the consumer receives from shared farming. Our modern system of food delivery is designed to provide a steady supply irrespective of season or climate, with only the prices changing. In shared farming, poor summers or even catastrophic events such as floods or hailstorms directly affect customers as well as producers. In these circumstances, the consumers lose along with the farmer. Urban residents thus experience direct links with the natural world.

A personal relationship between the farmer and consumers benefits all concerned. Although altruism is an element in a decision to share the risks taken on by a grower, there are tangible benefits to be had as well. Locally grown, fresh organic vegetables, produced on a small scale by a skilled farmer, will taste better and be better for us than food grown and purchased through conventional means.

HOW DOES IT AFFECT BIODIVERSITY?

CSA encourages the use of so-called heritage varieties, those "breeds" or variants that exist in isolated and small areas. Many of these varieties or species have superior pest resistance and nutritional qualities, and they are often better adapted to local conditions than the standard varieties of the agribusiness. By continuing to farm and sell produce from these localized animal and plant varieties, shared farming contributes to the maintenance of a wider, more robust, gene pool.



Unlike industrial farming, organic farming preserves and creates soil, and it conserves the diversity of soil-inhabiting species. The diversity of soil microorganisms are largely unknown (only a small fraction is scientifically described and named), but the functions of soil microorganisms are becoming better known and increasingly researched. Soil biota can prevent invasion of disease microorganisms and aid in the direct nutrition of plants by supplying nutrients and absorbing plant wastes. They also play a crucial role in nitrogen, phosphorus and other nutrient cycling.

In conclusion, shared farming can do two things at the same time. While providing substantial benefits to humans, it can also halt declines in the diversity of crop species, farm animal species, and soil biota.

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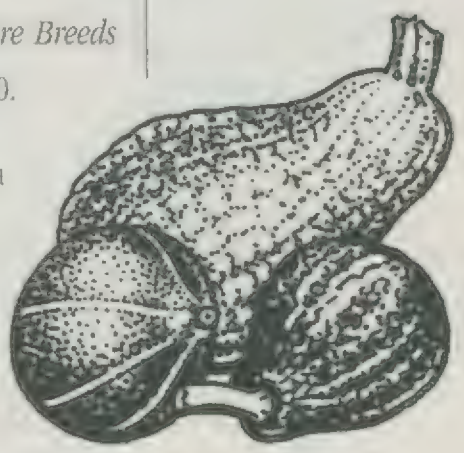
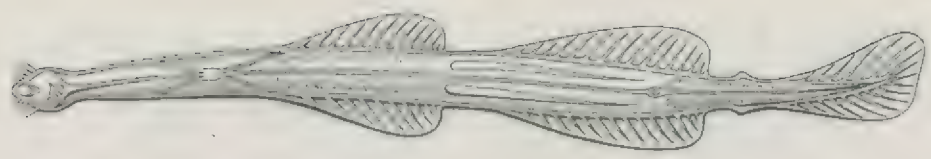




CANADIAN RATIFICATION OF THE LAW OF THE SEA CONVENTION:

No more excuses

Canada played a very active role in the negotiations leading to the United Nations Law of the Sea Convention (UNCLOS), as well it should with coastlines on three of the world's five oceans. Canada helped develop some of the innovative features of the Convention, such as the international sharing of benefits to deep sea mining. Not only does the Convention enhance Canada's declaration of sovereignty over its coastal waters, it also provides parameters for the sustainable use of the oceans and its biodiversity. (For more on the phenomenal biodiversity of the planets "seascapes," see Elliott Norse's article on page 4.) The World Federalists discuss why Canada should ratify the Convention, in spite of its recent reluctance on issues of foreign overfishing and deep sea mining.

[D.E.M.]

A Briefing Paper (February 1994)
prepared by *The World Federalists of Canada*
207 - 145 Spruce Street
Ottawa, Ontario K1R 6P1

STATEMENT OF THE ISSUE

After years of delay, the United Nations Law of the Sea Convention (UNCLOS) is about to come into force. On 19 November 1993, the 60th ratification of UNCLOS was deposited at the UN. Technically, the treaty becomes law one year after the 60th ratification. However, of the sixty countries which have ratified, all but two (Iceland and Malta) are developing countries. The treaty is a complex piece of international legislation, covering all uses of the world's oceans. To be truly effective, it should have universal support, including that of the major developed countries and marine powers.

Satisfying the developed country hold-outs requires a successful conclusion to the behind-the-scenes discussions aimed at resolving differences over some of the convention's seabed mining provisions. These discussions have been ongoing since 1990 under the auspices of the UN Secretary-General, and substantial progress has been made in recent months, in part due to the pressure of the treaty's impending entry into force. Resolution of the main outstanding issues is expected by this summer. This should clear the way for a number of middle power developed countries to ratify the convention this year and allow all other countries to accede to it in the next few years.

The Liberal Party of Canada was clear about its support for UNCLOS while in Opposition and during the election campaign. The famous Liberal "red book" of campaign promises could not have been more explicit. It stated, "We will ratify the Law of the Sea Convention."

Now, however, there is some doubt surrounding the prospects for Canadian ratification. Government officials, notably Fisheries Minister Brian Tobin, have been making belligerent comments threatening unspecified Canadian "unilateral actions" to stop foreign overfishing beyond Canada's 200-mile Exclusive Economic Zone (EEZ). (NOTE: The EEZ is defined by UNCLOS as: the area adjacent to a country's coastline extending 200 miles out to sea, within which economic activities such as fishing are regulated by the coastal state. The area beyond the EEZ is considered the high sea.)

Any Canadian actions to intercept foreign fishing vessels beyond Canada's 200-mile EEZ (e.g. on the nose and tail of the Grand Banks) would be a violation of international law, including provisions of UNCLOS. How could Canada ratify a convention and then turn around and violate one of its key provisions?

Thus, the prospect of Canadian unilateral action to protect the Grand Banks from overfishing may prevent Canada from ratifying UNCLOS. Instead, Canada should ratify the treaty as soon as possible, and then use the treaty's framework to resolve the problem of overfishing on the high seas.

BACKGROUND

It's been over 25 years since the first UN Conference on UNCLOS. At a time when international relations are changing so rapidly, UNCLOS is a painful reminder of just how long it can sometimes take for the development of international law under the treaty-making processes of the nation-state system.

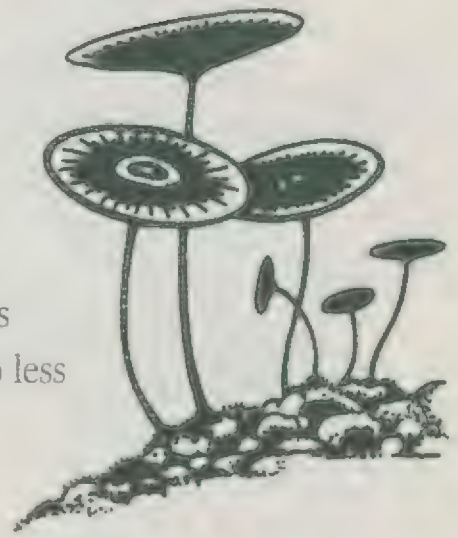
Every country in the world participated in the negotiations during the UN Conference, 1973-1982, which led to UNCLOS. Those negotiations covered a wide array of issues, from pollution prevention to mining the ocean floor. The result is a landmark achievement in international law. a virtual constitution for the world's oceans.

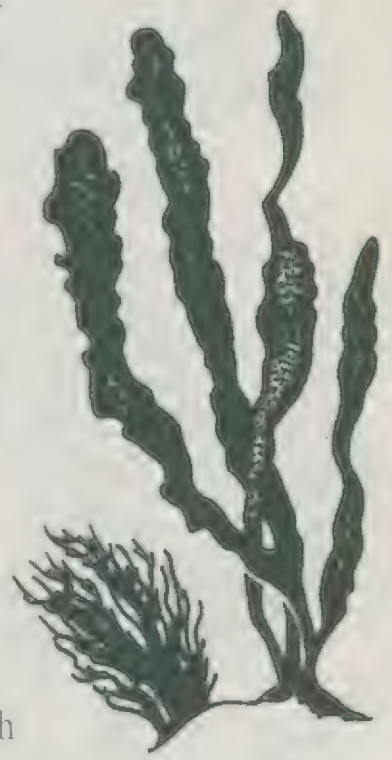
UNCLOS is composed of 17 main parts, 320 articles, and 9 annexes, and covers virtually all uses of the world's oceans. Treaty provisions set forth international law covering: exploration and exploitation of deep seabed mineral resources; the extent of coastal state jurisdiction, including rights and obligations of states in their management of coastal economic zones; delimitation of boundaries between opposite and adjacent states; navigation and overflight rights on the high seas, and in territorial seas, straits and archipelagos; the rights of landlocked and geographically disadvantaged states; protection of the marine environment; freedom of marine scientific research; and peaceful settlement of disputes.

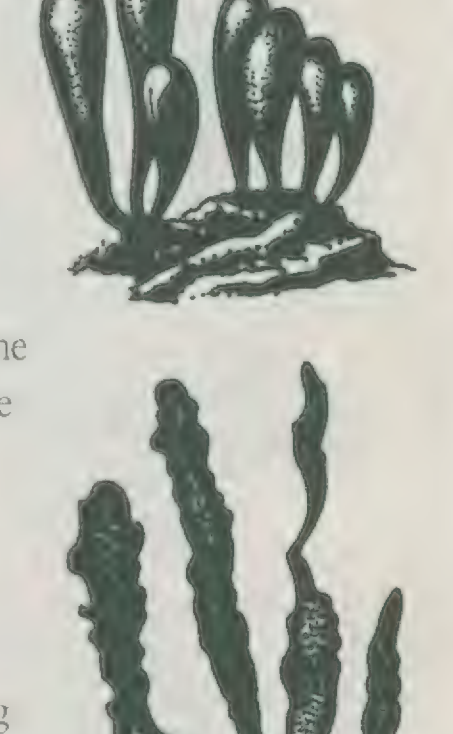
When the convention eventually comes into force it will also create new international institutions: an International Seabed Authority (including an Assembly, a Council, and a Secretariat) for administering implementation of the convention's provisions; a dispute settlement tribunal; and the "Enterprise," a body that is to participate in seabed mining and treat the resources of the ocean floor as the "common heritage of mankind."

Among the treaty's accomplishments:

- It embodies the recognition that the problems of the oceans are closely interrelated and need to be considered as a whole, thus spearheading a holistic approach to world affairs, as opposed to a fragmentary and sectoralized approach;
- It codifies and articulates the principle of the "common heritage of mankind," the idea that the oceans' resources belong to all of humanity and that all of humanity is entitled to share in the benefits of their use. When ocean mining begins (well into the next century) the common heritage principle ensures that a portion of revenues will be transferred to less wealthy countries;
- It institutes a comprehensive framework for both international environmental law and the management and conservation of marine resources;
- It provides a new set of rules for the conduct of marine scientific research and the development of marine technology;
- It creates a new type of international institution (the Seabed Authority), which has the power to impose international taxation and bring multinational companies into structured relationships. It may thus become a prototype for international organization in the 21st century;
- It establishes the most comprehensive and binding system for the peaceful settlement of disputes ever designed;
- It strengthens world peace by enjoining states in a process of cooperative development by creating a dispute settlement system, and by reserving for peaceful purposes the seabed, the high seas, and marine scientific research.



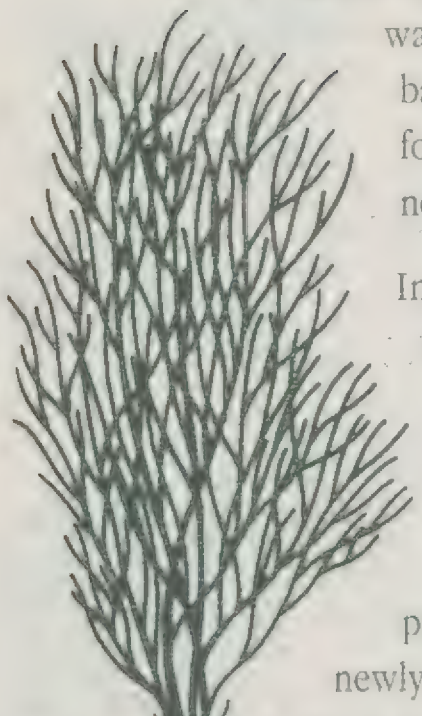




NEGOTIATIONS AND "INFORMAL CONSULTATIONS"

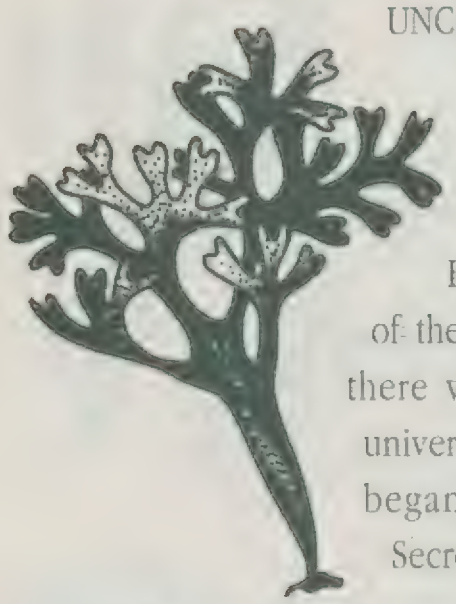
One of the keys to the negotiation of such a complex treaty was the format and decision-making process adopted at the 1973-82 UN Conference on UNCLOS. Participating states each had different priorities and interests. Military powers wanted to ensure rights of passage for their navies. States with long coastlines wanted to ensure their sovereignty over coastal waters. Landlocked states wanted to participate in the sharing of the wealth from mining the ocean floor and other uses of the high seas. There were also many

overlapping interests: protection of the marine environment, promoting marine research, and peaceful settlement of disputes. To negotiate a separate treaty for each of these issues would have been difficult. UNCLOS was negotiated on the basis that the final agreement would be a "package deal." No country got all that it wanted. However, through compromise and bargaining, a treaty emerged that all countries found to be of greater benefit than if there were no treaty at all.



In 1982, when UNCLOS was opened for signature, a record 159 states signed the treaty. (NOTE: Signing indicates an intention on the part of states to ratify the treaty; only when a country ratifies the treaty is it actually bound by the treaty's terms.) However, a few powerful states did not sign. In the U.S., the newly-elected Reagan administration reviewed the treaty and announced American opposition to Part XI of the Convention, the seabed mining provisions. They persuaded Britain and Germany to join them in withholding their signatures.

Following this action, a number of countries took a wait-and-see attitude, not knowing if UNCLOS would ever come into force. They did not want to open up for re-negotiation a treaty that had been negotiated in good faith as a package deal.



Eventually, it became apparent that the concerns of the hold-out states would need to be addressed if there was ever to be a treaty that could command universal adherence. In 1990 "informal consultations" began at the UN, under the sponsorship of the Secretary-General. They were aimed at overcoming the objections of the U.S. and a few other developed countries to the seabed mining provisions. These hold-outs are being wary. They view the International Seabed Authority potentially as another large, needless, expensive international bureaucracy. They also disapprove of restrictions the Authority would place on U.S.-based companies seeking to mine the oceans, including provisions requiring American companies to transfer mining technology.

More recently the prospect of the 60th ratification has added urgency to the Secretary-General's informal consultations. In August 1993, Satya Nandan of Fiji, a long-time UNCLOS diplomat, circulated a paper that reflected the concerns of most participants in the Secretary-General's consultations. This paper has been named the "Boat Paper" after the graphic on its cover page. Some changes to the Boat Paper were made in November and, with a meeting scheduled for early February 1994 and possibly one more this spring, there are now only a few remaining issues to be overcome.

The Boat Paper reduces the required financial contribution to the "Enterprise," the body created by UNCLOS to participate, with other multinational interests, in mining the seabed. (Seabed mining is decades away, due to low mineral prices on international markets.) The Boat Paper also changes voting and representation in the Council, the decision-making body of the Authority set up to administer UNCLOS. And the Paper allows non-ratifying countries to use a provisional membership in the Authority for a couple of years. This will allow countries that have not ratified or acceded to the treaty to participate in the work of the Authority in the meantime.

How are the changes reflected in the Boat Paper going to be incorporated in a treaty which was has not been open for negotiation in over ten years? Here Mr. Nandan and others engage in the kind of carefully crafted doublespeak that would make George Orwell proud. Although negotiation is precisely what has occurred, the discussions sponsored by the Secretary-General are called "informal consultations." The changes to the treaty are known as "adjustments," not amendments, although amending the treaty is precisely their effect.

These "adjustments" will be incorporated into the treaty by way of a UN General Assembly resolution, likely to be passed this summer. (The General Assembly, which usually meets in the fall, will be resumed especially for this purpose.) This will allow a number of countries to ratify before the November deadline.

WHAT ABOUT CANADA?

Canada was among the biggest winners from the UNCLOS negotiations. UNCLOS enhances Canadian sovereignty over coastal waters and contributes to a stable, more peaceful legal order for the oceans; UNCLOS also specifically protects salmon stocks and enshrines in international law the Arctic Waters Pollution Prevention Act. As a middle power committed to the rule of international law, and as a country bordered on three coasts by ocean waters, Canada's overriding interest is in the earliest possible universal acceptance of UNCLOS.

If Canada is one of the first to ratify the treaty, it would allow Canada to be in on the setting up of the UNCLOS institutions. We would probably end up with a Canadian judge on the UNCLOS tribunal and a Canadian seat at the Council (the UNCLOS decision-making body).

However, recent developments suggest that Canada may want to delay ratification indefinitely. In fact, Canada may be considering sacrificing all of UNCLOS in order to be able to intercept foreign fishing vessels off the coast of Newfoundland!

The tragedy of the decline of the East Coast cod stocks is well known to Canadians. When thousands of families in an already depressed region of the country lose their livelihood and source of income, it's natural that politicians would also feel the heat of public anger and frustration. In turn, they are pressured to find other scapegoats and to appear to be "doing something" about the problem.

Perhaps that's the best explanation for some intemperate remarks by Canada's new Minister of Fisheries and Oceans, Brian Tobin. On 16 November 1993, in an address delivered in Moncton to the National Fish Harvesters Professionalization Conference, Tobin stated, "Uncontrolled fishing outside 200 miles must never again be allowed to decimate a world food source, threaten the future of hundreds of communities, and undermine a centuries-old way of life....The Government of Canada will no longer tolerate a situation where our fishermen have stopped harvesting a resource inside 200 miles, but others continue to plunder that same resource outside 200 miles....Foreign overfishing will be stopped by agreement, if possible. *Foreign overfishing will be stopped by unilateral action, if necessary."* (our emphasis)

In these remarks Tobin was echoing similar statements made in Washington by Newfoundland Premier Clyde Wells. Tobin repeated these vague threats in January while addressing the representatives of the European Communities. And the Speech from the Throne on 18 January 1994, included the following: "Canada will take the action required to ensure that foreign overfishing of East Coast stocks comes to an end." And although the throne speech read like a grocery list of the Liberal's 1993 campaign pledges, the promise of Canadian ratification of UNCLOS was conspicuously absent.

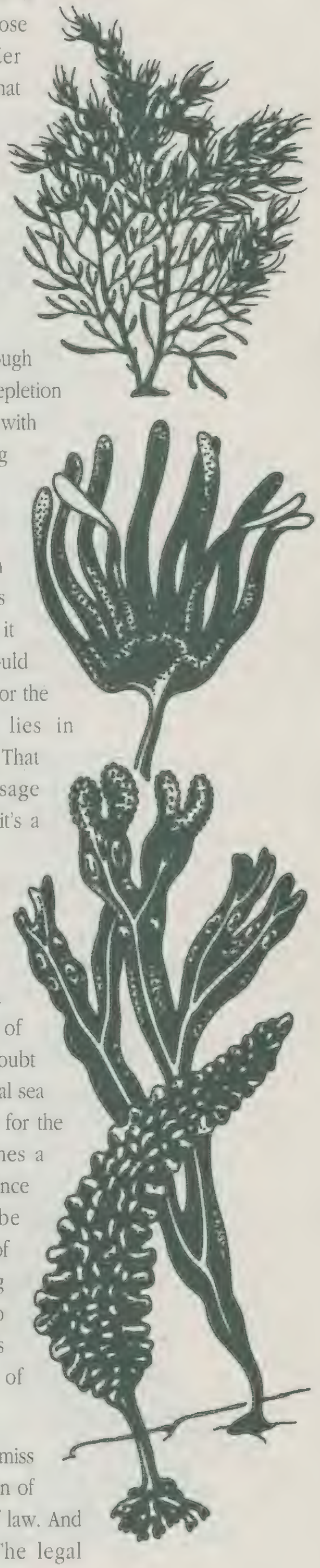
The notion that Canada would realistically contemplate military action to intercept foreign fishing vessels on the high seas seems far-fetched. In the first place, it's illegal, as *The Globe and Mail* pointed out on in a January editorial entitled "Mr. Tobin's loose lips." Even if it were not illegal under international law, it's not a policy option that Canada could sustain. We can scarcely find the funds to compensate unemployed fishermen; are we in addition going to mount an expensive military action to police the nose and tail of the Grand Banks for years into the future until the cod stocks are replenished?

There's only one reason for Mr. Tobin's tough talk: it plays well on the east coast. The depletion of the fishery is an ecological catastrophe with devastating social impacts. Fishing communities are looking for dramatic action from their government.

But there's no way that Canada, a modern nation with international responsibilities, is going to conduct its foreign policy as if it were Greenpeace. Instead, Mr. Tobin should be telling Canadians that the only remedy for the depletion of the east coast fishery lies in international negotiation and diplomacy. That may not be the kind of dramatic message unemployed fishermen want to hear. But it's a lot closer to the truth.

What's worse is that Mr. Tobin's desire to present the prospect of unilateral Canadian action as a realistic policy option may actually be preventing Canada from ratifying UNCLOS. Canadian ratification of UNCLOS would demonstrate beyond a doubt Canada's intention to live within international sea law and would reveal Mr. Tobin's rhetoric for the idle bluster that it is. UNCLOS establishes a number of dispute settlement tribunals; once Canada ratifies the treaty, we could be brought to court for carrying out the sort of action that Mr. Tobin is suggesting. As long as the government feels the need to threaten intercepting foreign fishing vessels beyond the 200-mile limit; ratification of UNCLOS is on hold.

If Canada does not ratify UNCLOS, it will miss out on the opportunity to settle the question of foreign overfishing peacefully, in a court of law. And that is the greatest tragedy of all. The legal



framework of UNCLOS is Canada's best bet to stop foreign overfishing! Here's what UNCLOS has to say on the matter of straddling stocks (i.e. fish stocks found within and beyond a country's 200-mile Exclusive Economic Zone): "the coastal state and the states fishing for such stocks in the adjacent area shall seek...to agree upon measures necessary to ensure conservation of these stocks in the adjacent area." Thus the Convention creates an obligation to negotiate measures for the conservation of straddling stocks. This has, in fact, been under way for some time. Through the NAFO (North Atlantic Fisheries Organization) Canada has been pressing European nations to agree on reduced cod quotas.

But that's not all. Let's assume that the reduced cod quotas, which have been negotiated through NAFO, are not low enough. Or let's assume that some European fishing companies try to have their ships registered in another non-NAFO country (e.g. a "flag of convenience" such as Panama or Honduras) in order to avoid compliance with NAFO quotas. What then? At present, there's little Canada can do to stop such actions. But once UNCLOS comes into force, the treaty's judicial remedies will be available to countries like Canada.

UNCLOS's dispute settlement provisions are binding. In other words, once the treaty is in force, Canada could take the governments of overfishing countries to court. (In all probability, the mere threat of such action is all that would be required.)

That's why Canada's interest is in ratifying and promoting UNCLOS, not undermining it.

WORLD FEDERALIST ANALYSIS

As steps toward the democratic rule of law in world affairs, world federalists often support the development of international treaties. By pooling sovereignty to pursue common interests through international treaty law, nations also build the confidence and common interests that make conflict less likely.

However, UNCLOS is more than just another multilateral treaty. It is of special interest to world federalists largely because it enshrines—in law—the concept of the oceans as humanity's common heritage. Here is one major area of international affairs where the pursuit of national sovereignty ends, and where the shared responsibility for global governance begins.

Elisabeth Mann-Borgese, Honourary President of the World Federalists of Canada, has spent years working for UNCLOS. In her words the treaty "is the only existing legal document that gives a legal and economic content to the concept of the Common Heritage of Mankind; the only existing legal instrument that contains a comprehensive, binding, enforceable international environmental law, that effectively integrates environment and development....UNCLOS is giving rise to institutional restructuring for the governance of sustainable ocean management which may hold lessons for the governance of other global economic/ecological concerns during the next century."

For world federalists, the treaty is more than just a complex legal document. It represents a significant step forward in humanity's quest to bring international relations under the rule of law.

RECOMMENDED ACTION

Short letters urging that Canada ratify the Law of the Sea Convention should be sent to:

Hon. André Ouellet
Minister for Foreign Affairs
Lester B. Pearson Building
125 Sussex Drive
Ottawa, Ontario
K1A 0G2

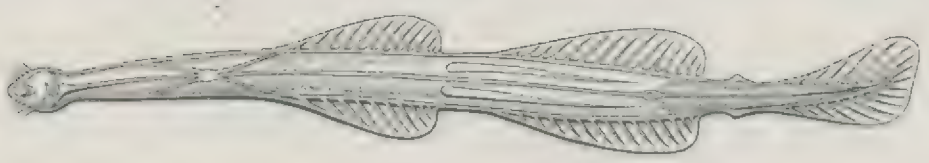
If possible, send a copy of your letter to your own MP and to Fisheries Minister Brian Tobin (c/o House of Commons, Ottawa, Ont. K1A 0A6).

FURTHER READING

Sanger, Clyde. 1986. Ordering the oceans. University of Toronto Press. 225 pp.

UPDATE: MAY 1994

On March 15, André Ouellet addressed Parliament on Canada's foreign policy. In the address, he stated, "...the Government will be ratifying the Law of the Sea Convention this year." We can only hope that the ratification will come before the November deadline.



A MOST INTERESTING CANOE TRIP:

Where are all the loons going?

Robert Alvo's observations help us all understand why all the loons are disappearing.

[D.E.M.]

Robert Z. Alvo
5 Cambertin
Cantley, Quebec, Canada

If you were canoeing up in the north country and saw a Common Loon leading its two chicks from one lake through some shallow rapids into another lake, you probably wouldn't think twice about it — but I did. My work on loons in the Sudbury, Ontario area from 1982 on had already shown that loons were having trouble raising chicks on acid lakes. Even though loons would sometimes try to nest on acid lakes, the chicks often died a few weeks after hatching, probably from starvation.

In fact, after 10 years of surveying the same 30 to 40 lakes, I have not been able to find *any* successful pairs on lakes with pH less than 4.5. Very large lakes with pH slightly above 4.5 sometimes have successful pairs, because these lakes probably still contain some hardy fish, invertebrates and aquatic plants, even though in reduced densities. Thus the loons, which feed all of these to their young, can raise the chicks to the flying stage. The juveniles are at last free to fly to other more plentiful lakes. In contrast, highly acidic lakes, with a pH less than 4.5, seem to have no fish and really very little else besides algae-covered sediments.

When I saw the adult lead the two chicks from one lake to the other, the two lakes had pHs of 4.5 and 4.6 respectively. For two years, I had had a hunch that one pair was using the two lakes. On several occasions I had seen one vocal adult in one lake and another adult with a chick in the other lake. On another occasion, I had seen an adult fly from one lake toward, and presumably into, the other. In non-acidic conditions, two or even three pairs of loons could have shared two large lakes. At such a low pH, however, there seems to be enough food for only one pair to attempt to raise young.

It would have been interesting to go back a couple of weeks later, just before the young would have been able to fly, to see whether both chicks had survived. I did note that they stayed very close to the parent the whole time I was there, and they begged almost continuously. The sound carried up to 200 metres – something I have never noticed from young on non-acidic lakes.

FURTHER READING

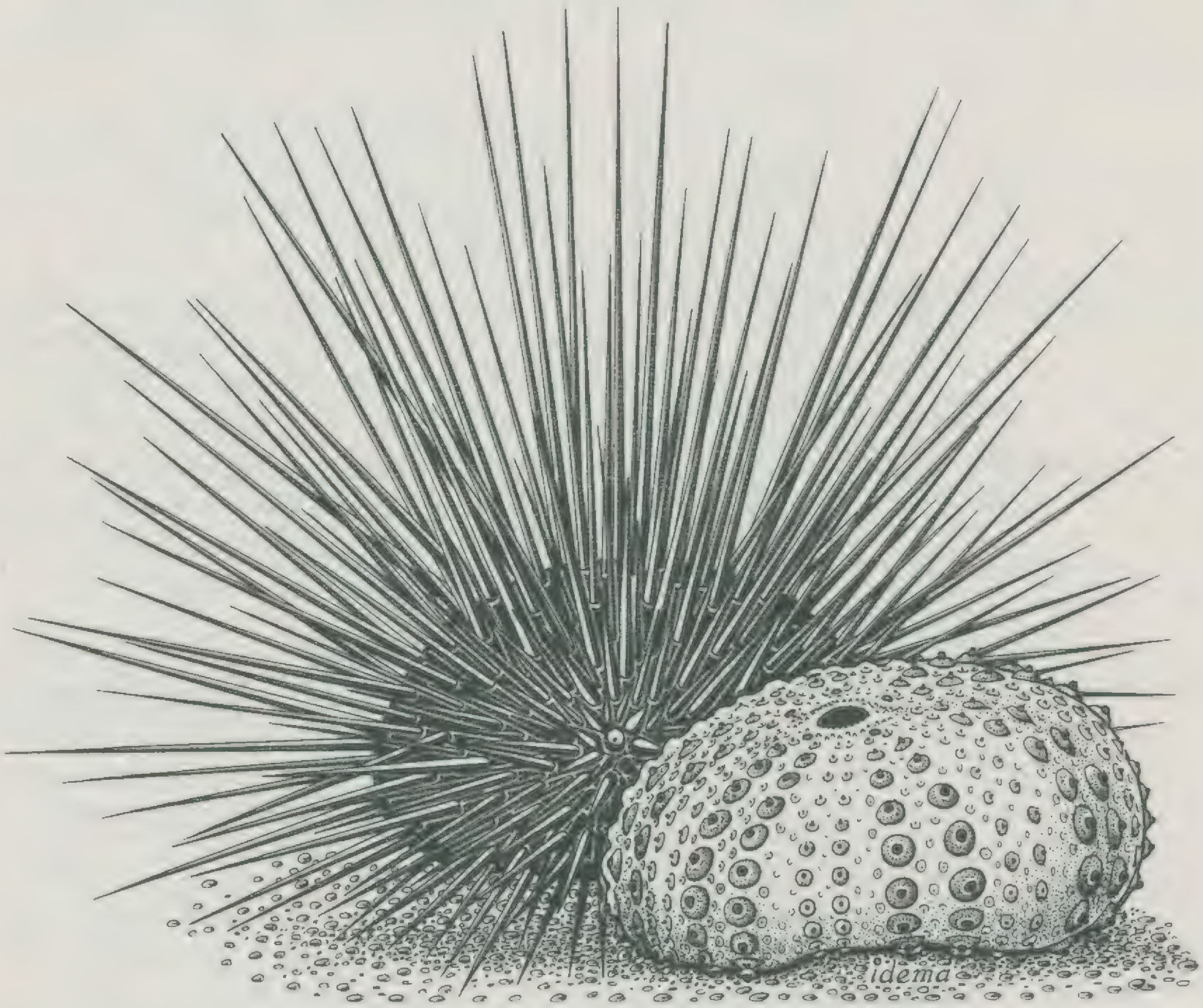
Alvo, R. 1987. Is the laughter of loons to be stilled on our acid lakes? Canadian Geographic June, 1987.

Alvo, R. 1986. Lost loons on acid lakes. Natural History, September, 1986.

Alvo, R., Russell, D.J.T., and Berrill, M. 1988. The breeding success of common loons (*Gavia immer*) in relation to alkalinity and other lake characteristics in Ontario. Canadian Journal of Zoology 66: 746-752.

Alvo, R. In Preparation. Common loon. *In*: Quebec Breeding Bird Atlas. Canadian Wildlife Service.

Parker, K.E. 1988. Common loon reproduction and chick feeding on acidified lakes in Adirondack Park, New York. Canadian Journal of Zoology 66: 804-810.

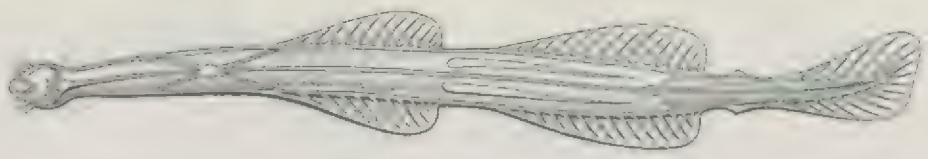


Black long-spined sea urchin

Diadema antillarum Phillipi

Diadema antillarum Phillipi is commonly known as the Black long-spined sea urchin and belongs the phylum Echinodermata, which includes starfishes, brittle stars, feather-stars, and sea cucumbers. Protruding from their bodies, all echinoderms have "tube feet" that help the animals in moving, feeding, breathing, and producing mucous. Almost all echinoderms display a five-rayed symmetry.

The skeleton is formed inside the body and therefore called a test, not a shell. The test shown here is from a related species. One can see the tubercules that bore the spines, the holes where the tube feet protruded, and the skeleton plates that make up the test.



A GLOBAL DATABASE OF CORAL REEF SYSTEMS AND THEIR RESOURCES:

REEFBASE

Contact:
Dr. John McManus
Project Leader (REEFBASE)
Coastal and Coral Reef Resource Systems Program
ICLARM
M.C.P.O. Box 2631
Makati, Metro Manila 0718
Philippines
Fax: (63-2) 816 3183

A project to develop a global database on coral reef systems and their resources, to be called REEFBASE, was initiated at the Manila-based International Center for Living Aquatic Resources Management (ICLARM) in November 1993. The Commission of European Communities has provided funding for the first two years, and the database will be developed in collaboration with the World Conservation Monitoring Centre in Cambridge, U.K., as well as in other regional and international institutions.

Coral reefs, the marine equivalents of tropical rain forests, are under threat in many parts of the world as a result of habitat degradation, over-exploitation, and possibly, global climate change. Although fragile, coral reefs are highly productive and can support high levels of sustained fishing, if the fishing is sensibly regulated. If they are in good condition, they also have great value as tourist attractions. In many parts of the world these economic benefits are being eroded by siltation from poor land management, nutrient enrichment from sewage, other forms of pollution, destructive fishing practices, and intensive use by tourists. However, the magnitude of these impacts are largely undetermined and undocumented. Basic questions such as "what is the total area of coral reefs in the world?" and "what is the contribution of reefs to the world's fisheries?" are still unanswered.

As currently envisaged, REEFBASE users, through a global map on their computer screen, will be able to focus on any country, reef system, or individual reef to obtain details of reef area, species composition, coral cover, catch rates and composition of reef fish and invertebrates, recreation and other forms of resource use, human impacts, management efforts and indigenous knowledge. Current discussions among reef scientists on common methodologies and terminology are being used as a starting point for designing the data entry fields.

The preliminary focus will be on obtaining estimates for reef areas, which in many cases will necessitate literature searches and correspondence with a wide range of individuals. Initial figures may well be approximate but will be replaced with more reliable data as the project progresses. Information on other aspects will initially be entered on a more *ad hoc* basis with the emphasis on linking with other data collection programmes, rather than collecting and inputting raw data. Each data entry will be flagged according to its reliability, and will be referenced and acknowledged.

ICLARM is a non-profit, non-governmental research centre and is a member of the Consultative Group on International Agricultural Research (CGIAR), a worldwide network of research centres supported by international donors. It carries out research and disseminates information on all aspects of aquatic resource management, with the aim of improving sustainable production and management of fisheries resources for present and future generations of low-income users in tropical developing countries.

Art courtesy of Ocean Voice International.

REEFBASE will provide data from which it should be possible to quantify changes in reef health at national and global levels, thus providing conservation organizations, governments, and the media with the statistics and information that are needed to implement policy changes. REEFBASE will also be useful in identifying future research priorities and could serve as a framework for the development of analytical tools. This has been done on a small scale in Australia, where data compiled for the Great Barrier Reef is being used to identify patterns of ecology and structure and as a management tool.

REEFBASE will draw upon the experience gained with FISHBASE, a large database on fish biology, also developed at ICLARM with funding by the European Communities It will link with this database as well as national and regional databases, such as ASEAN and the Australia Living Coastal Resources Project, a regional reef monitoring programme in Southeast Asia, and CORALBASE, a coral taxonomic database being developed at the Australian Institute of Marine Science. Once other data-gathering programmes are developed, REEFBASE will link in with them, too.

In order to accomplish these objectives, ICLARM will develop a global network of collaborating scientists and institutions. In developing countries, where coral reefs are the most extensive and most threatened, means will also be sought to provide technical assistance in data acquisition and to enable scientists in the developing country to fully develop their skills by further training or appropriate linkages with advanced research laboratories and universities. These researchers can then benefit from the global context that REEFBASE will provide, and at the same time, augment and contribute themselves to the database, an activity for which they will be fully credited.

The first version of REEFBASE will be distributed to all collaborators in about 1996. The software will run on IBM compatible microcomputers, which are now available in most offices and laboratories. Subsequent revised and updated versions will be distributed at nominal cost to all relevant national and international research and management institutions and individuals.

Biodiversity News Notes

Global biodiversity designs new environmentally friendly targeted direct mailing package

Over the last three years, *Global biodiversity* has established a successful format of content and design. In order to support this much needed publication, more subscribers are needed, and so in early 1994, *Global biodiversity* investigated the best way to capture more subscribers. The result is an innovative targeted direct mailing package.

Readers may wonder why the Museum chose a direct mail package in the first place. The following paragraph from *E Magazine* (December 1993) helps to explain why:

Direct mail exists because it works. It generates response rates from the public that are tens, hundreds, even thousands of times better than ads in newspapers or on TV.... It (the Direct Marketing Association) found that the basic problem isn't what the public assumes. "We came to the conclusion that trees are not the issue. They are renewable. We see the real issue as landfills."

Concerned that our advertising efforts could negatively affect biodiversity, and yet needing to use the best tool available to increase circulation, *Global biodiversity* chose to pursue direct mail marketing but in a responsible way. Thanks to an innovative design by Karen Temple, an Ottawa designer, the new package uses 47% less paper than a regular package. Printed on 100% post-consumer waste, recycled paper and with water soluble glue and vegetable-dye inks, the whole package can be recycled. Better yet, the package encourages the reader to pass it on to a friend.

If you are planning a mailing and would like to take advantage of our discoveries, or if you or your association would like to swap lists, please contact Dawn Arnold, Production Manager at (613) 993-5908.

Mangrove forest or a shrimp farm in Honduras?

In Honduras. with the assistance of a local non-governmental organization, women protested a plan to convert a 1,000 hectare lagoon, rich in mangrove forests, into a commercial shrimp farm. The project threatened the mangrove forests and the livelihoods of 2,000 families residing in nearby fishing communities. Ms. Anguilera organized the local communities in opposition to the project. As a result of her efforts, the mangrove area was preserved and designated as a natural reserve by the Ministry of Natural Resources. [*WorldWIDE News*, Winter 1993, p. 8]. All around the tropics mangrove forests are being subject to this and other threats.

Tropical hardwood shortage means plastic musical instruments

Tropical hardwoods are disappearing, and by the end of the decade, violins will have to be made from plastic, according to the Fauna and Floral Preservation Society in London, England. Dense woods such as ebony and rosewoods. which resonate with the best sound and do not warp or crack, are traditionally used by musical instrument makers. These trees are slow-growing and the stocks are nearing extinction. Brazilian rosewood has been banned from international trade and Indian rosewood, now being used as a substitute, is rapidly being exhausted. Likewise supplies of pernambuco, used for violin bows, and impago (an African blackwood), used for clarinets and oboes, are falling dangerously low. Yamaha, the world's biggest maker of instruments, is developing a synthetic substitute for the ebony in piano keys. The Faunal and Floral Society is marking its 90th anniversary with a project to establish nurseries and manage existing supplies in East Africa and Brazil. [*Ottawa Citizen*, 17 December 1993, p. D9]. Perhaps music lovers should hold concerts to collect money to save forests.

Green product labelling arrives in the European Communities

The European Communities (EC), as part of them harmonization initiative, is building on the success of national-level labelling programs by introducing the EC Eco-Logo, a green flower topped by 12 stars. EC Eco-Logo products are now appearing on European store shelves. Ten product groups will be covered by the program, which will replace the current national schemes. Germany has had the most extensive national scheme in which over 1,500 products are registered and widely accepted by consumers. The standardization will make it easier for North American exporters to enter a European market, now unified under a single "green label" scheme—and encourage them to enhance their product standards where lacking. [*Terrascope*, Autum 1993, 1(1): 2].

The logo above is the Eco-logo of the European Communities. The one below is the Canadian Environmental Choice logo.

M - Official mark of Environment Canada
M - Marque officielle d'Environnement Canada

Canada has had an Environmental Choice green label scheme for five years. Environmental Choice has over 150 licensees and over 750 products. (If you are interested in registering with Environmental Choice, contact: Environmental Choice, Environment Canada, 107 Sparks Street, 2nd floor, Ottawa, Ontario, K1A 0H3. Phone (613) 952-9440. Fax (613) 952-9465) The U.S. is also developing a Green Seal program, and Mexico lacks such a scheme. Unfortunately the recently ratified North American Free Trade Agreement (NAFTA) only mentioned eco-labelling as a possible topic for discussion in the environmental side deal introduced by the U.S. This missed an opportunity to upgrade environmental standards, while promoting more intensive trade.

1994 IUCN General Assembly

The XIX General Assembly of The World Conservation Union (IUCN) was held in Buenos Aires, Argentina, from 17 January to 26 January 1994, bringing together some 1200 participants. Established in 1948, IUCN is an international organization made up of government and non-government organizations. It links over 6,000 scientists and professionals.

In opening the Assembly, His Excellency Carlos Saul Menem, President of the Republic of Argentina described ecology as not only *one* of the matters of interest regarding the world but as *the* central matter that humanity has to pay attention to. He indicated the reason for his participation was to try to find new ways to have a non-aggressive world, a world that, in the environmental field, will achieve the same cooperation that the nations have today in the political and commercial fields.

Sir Shridath Ramphal, the outgoing President of IUCN and former Commonwealth Secretary General, referred to the "Earth's carrying capacity" and regretted the silence among politicians at the Earth Summit on problems of population and consumption. "The silence on consumption at Rio was the silence of guilt—and beyond guilt, a forlorn hope that if decisions can be deferred long enough and solutions sought in other directions, changing the lifestyles of the rich may not be necessary after all. But silence does not change reality." He added: "The insistence [at Rio] of a few oil-producing countries that the final documents should not give prominence to new and renewable sources of energy signalled the existence of dangerous alliances in the war against unsustainable living."

Dr. Jay D. Hair of the United States was elected Union President. He is a former U.S. National Wildlife Federation President and comes to the Union highly recommended by Vice-President Al Gore. He is seen as a leader in U.S. National policy advancement based on environmentally sustainable development principles.

Former Ambassador David McDowell of New Zealand who is succeeding Dr. Holdgate as Director General also attended the meeting.

David Runnalls, Senior Advisor, International Development Research Centre, Ottawa, was re-elected for a second term as one of three North American and Caribbean councillors.

The Assembly passed a record 100 resolutions on conservation issues. Ten workshops allowed brainstorming sessions focused on *Caring for the Earth - A strategy for sustainable living*, a major theme of the IUCN's work.

In his closing remarks Dr. Holdgate, the outgoing Director General, stressed that the IUCN must be a union of regions, not a collection of regions. He called on members to respect diversity of opinions, and asked that each adjust their differences toward a common goal. "The Union must be guided by science but sensitive to social elements." He said that the split that is occurring between views on development and conservation puts the Union at risk of becoming unmanageable. "We're at a parting of the ways" and "the time has come to end sterile, circular arguments over the balance IUCN should seek between conservation and development."

Outgoing President Ramphal took the conservation debate one step further by warning that unless the IUCN shifts its focus in line with the changing international game plan, it could miss the chance to make a difference for humankind.

The new President, Dr. Hair in his closing statements posed the question, "How do we meet the challenges of conservation in a changing world?" He suggested that people at both ends of the conservation spectrum should consider leaving IUCN. "We must develop clear criteria for qualifications for membership," he said. "Members must subscribe to the Union's mission statement in their works. Otherwise IUCN is not for them—whether they are strictly conservationists or only for development."

As members get back to work in one of the 125 countries they represent and as the IUCN leadership

grapples with new challenges, all eyes are set now on Hair and McDowell to follow up the good work of Ramphal and Holdgate—and join them in the ranks of the world's top environmental diplomats.

The XXth General Assembly of IUCN will be held in Montreal, Canada, in October 1996. [Anne Breau, Canadian Centre for Biodiversity, CMN]

Canada releases a draft biodiversity strategy for public input

A draft of the Canadian Biodiversity Strategy, a greenprint to save and wisely use the diversity of life in Canada and elsewhere on Earth, will be released mid-June. Public input into the document, under development for over a year, will be invited before finalizing and adopting the Strategy in November 1994.

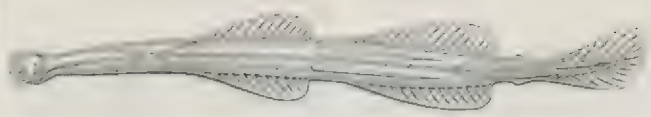
The Strategy will embody Canada's response to what is arguably the most important convention ever ratified, the International Convention on Biological Diversity. Successful implementation could do much to ensure the survival of all forms of life on Earth and the quality of human life.

The Strategy will provide a "map" for the conservation of biodiversity, for the sustainable use of biological resources, and for the equitable sharing of the benefits from resources. While governments, NGOs, industry, and citizens have taken a few serious steps toward the protection and wise use of biodiversity, only a beginning has been made in the transformation that is needed to ensure an enduring future for ourselves and fellow life forms. And there are powerful Jurassic-era guardians of the status quo.

For these reasons, thoughtful input by Canadians and Canadian organizations is vital for the development of an effective strategy. The draft strategy, which will be provided to the public, was prepared by committees involving federal, provincial, and territorial governments, NGOs, business and industry representatives, and other stakeholder groups, chaired by the Biodiversity Convention Office of Environment Canada (see *Global biodiversity* 1993, Volume 3, Number 3, pp. 4-5 for further details on the process). Those in other countries may wish to study the results of the Canadian process, now at its halfway point.

Concerned Canadians should take this once-in-a-lifetime opportunity to comment on the survival of the diversity of life, how we should manage our biological resources, strengthen our biodiversity research and educational capacities, and equitably share the benefits. This is the opportunity for an all-embracing strategy and a chance to orient ourselves so that we are in harmony with the Earth and its life.

Your feedback on the draft, available mid-June, can be forwarded to, The Biodiversity Convention Office, Environment Canada, Place Vincent Massey, Hull, Québec K1A 0H3, Canada. Phone: (819) 953-4374, Fax: (819) 953-1765. [D.E.M.]



Biodiversity Meetings

12-15 JULY 1994.
Sustaining the Ecological Integrity of Large Floodplain Rivers: Application of Ecological Knowledge to River Management, to be held in La Crosse, Wisconsin.

18-22 JULY 1994
Prospects for Carbon Sequestration in the Biosphere (NATO Advanced Research Workshop) to be held in Edinburgh, U.K.

Contact: Prof. O. Heal
Institute of Terrestrial Ecology (North)
Edinburgh Research Station
Penicuik, Midlothian
U.K. EH26 OQB

20-22 JULY 1994
The 1994 ASAB Summer Meeting, Evolution of Signalling, to be held at Bern, Switzerland.

Contact: Manfred Milinski
Universität Bern, Sektion Ethologie
Wohlenstrasse 50a
CH-3032 Hinterkappelen
Switzerland

25 JULY - 5 AUGUST 1994
International Composite Conference, to be held in Kew, U.K.

Contact: Mr. C. Jeffrey
Herbarium, Royal Botanic Gardens
Kew, Richmond, Surrey
U.K. TW9 3AE

8-10 AUGUST 1994
International Symposium on Global Change in Asia and the Pacific Regions, to be held in Beijing, China.

Contact: Dr. Su Yafang
LREIS Institute of Geography
Bldg. 917, Datun Rd.
Anwai, Beijing 100101
China

20-25 AUGUST 1994
21st International Ornithological Conference, to be held in Vienna, Austria.

Contact: IOC Interconvention
Friedrichstrasse 7, A-1043
Vienna,
Austria

17-25 AUGUST 1994
ICSEB V.:
Fifth International Congress of Systematic and Evolutionary Biology, to be held in Budapest, Hungary.

Contact: IBUSZ Congress Dept.
RCS: 551-003-096 ICSEB V.
Ferenciek tere 2
H-1053 BUDAPEST
Hungary
Tel: (36-1) 118-3362 117-5717
Fax: (36-1) 118-9161

20-26 AUGUST 1994
6th International Congress of Ecology, to be held in Manchester, U.K.

Contact: The Secretary
VI International Congress of Ecology
Dept. of Environmental Biology
The University, Manchester
U.K. M13 9PL

28 AUGUST - 03 SEPTEMBER 1994
Measuring and Monitoring Biodiversity in Tropical and Temperate Forests, to be held in Chang Mai, Thailand.

Contact: Secretariat
Forest Biodiversity Symposium
Royal Forest Department
Silvicultural Research Subdivision
61 Paholyothin Rd., Chatuchak
Bangkok,
Thailand 10900
Fax: (66-2) 5794730 or
(819) 997-8697

4-9 SEPTEMBER 1994
International Conference on Biodiversity and Development: Towards a New Partnership, to be held in Paris, France.

Contact: IUBS
51 Bd de Montmorency
75016 Paris
France

18-22 SEPTEMBER 1994
1994 AZA (Aquarium and Zoo Association) Annual Conference, to be held in Atlanta, Georgia, U.S.A.

Contact: Paul Grayson
Conference Program Chairperson
Indianapolis Zoo
1200 Washington St.
Indianapolis IN 46218
Tel: (317) 630-2054
Fax: (317) 630-5153

24-28 OCTOBER 1994
Down to Earth: Practical Applications of Ecological Economics - An International Transdisciplinary Conference, to be held in San José, Costa Rica.

Contact: International Conference of Ecological Economics
P.O. Box 555
3000 Heredia
Costa Rica

7-18 NOVEMBER 1994
Ninth Meeting of the Parties to CITES, to be held in Fort Lauderdale, Florida, USA.

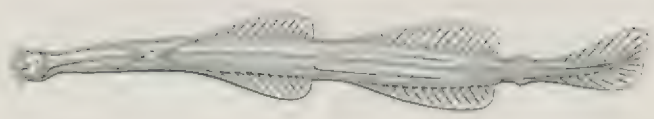
Contact: CITES Secretariat
United Nations Environment Programme
Case postale 456,
CH-1219 Châtelaine,
Geneva
Switzerland
Tel: (41-22) 979 9111
Fax: (41-22) 797 3417

10-13 NOVEMBER 1994
Forest Canopies - Ecology, Biodiversity, and Conservation, to be held in Sarasota, Florida, U.S.A.

Contact: Meg Lowman, Director of Research
Selby Botanical Gardens
811 South Palm Ave.
Sarasota, Florida 34236
U.S.A.

18-19 NOVEMBER 1994
Biodiversity from 1986 to the 21st Century - an inaugural symposium of the Consortium for Systematics and Biodiversity, to be held in Washington, D.C.

Contact: Dr. Marjorie Reaka-Kudla
Department of Zoology
University of Maryland
College Park, Maryland 20742
U.S.A.
Tel: (301) 405-6944



Book and Periodical Niche

Tales of a shaman's apprentice. An ethnobotanist searches for new medicines in the Amazon rain forest.

By Mark J. Plotkin. 1993. Viking, Penguin Group, 375 Hudson Street, New York, New York 10014, U.S.A. 318 pp., photos. Hardcover, ISBN 0-670-83137-9.

This book describes, in lively text, the ethnobotanical discovery of shamans' knowledge of medical and other uses of plants in the northeast Amazonian rain forest. The indigenous peoples have explored the wealth of plants in rain forests for thousands of years. They have developed their own taxonomy and field recognition techniques for this exceedingly rich flora. From plants, they derive medicines, foods (wild, semi-domesticated, and domesticated), cosmetics, perfumes, basketry, canoes, tools, and weapons. Their natural medicines are used to treat fevers, toothaches, skin infections, insect stings, ear aches, and many other ailments. Plant derivatives also serve as stimulants, contraceptives, and hallucinogens.

Plotkin relates how this precious encyclopedia of ethnobotanical knowledge is rapidly disappearing under the onslaught of western education, deculturation, and religious instruction. Plotkin began a program of collecting and identifying the plants with their tribal names, and providing written copies of the knowledge to the tribe in their own language, often the only book in their language other than the bible. He also briefly describes the establishment of Shaman Pharmaceuticals, an American firm, which develops medicines from indigenous sources and turns some of the funds generated back to the originating peoples and to botanical research.

The botanical plot is interwoven with encounters with tapirs, butterflies, howler monkeys, humming birds, giant anteaters, black caimans, and various kinds of ants.

This is an exciting book, a human story of contacts between indigenous peoples and a botanist, an excellent read. It will give you refreshing insights into the breadth of indigenous knowledge and the biodiversity of tropical rain forests. It should inspire governments and individuals to save the diversity of nature and indigenous cultures.[D.E.M.]

Permaculture: A practical guide for a sustainable future

By Bill Mollison. 1990. Tagari Publications, Tvalgum, Australia. Hardcover, ISBN 0-90822-8015, $34.95.

For a decade, *sustainable development* has been a popular catch phrase. It has also been an abused, misunderstood, and misrepresented phrase. Some resource extractive industries view it as a continuation of development until their particular activity cannot be sustained. The moribund cod fishery on the East Coast of Canada is a classic example of this form of "sustainable development"! Green advertising bombards the public with motherhood statements about "environmentally friendly" activities or products, and many people are proud of their efforts to save the environment by recycling household paper, glass, and tins. Far too often, however, it is those same people who drive large cars to the corner store, have immaculate, manicured, chemically treated lawns, and have memberships in golf courses that exist where wetlands once burst with life. Good intentions exist, but specific knowledge or practical means to an end are lacking.

A paradigm shift is required, a shift that would bring awareness of lifestyle choices and their impact on natural systems to the forefront of the everybody's life. Guides to this new awareness are desperately needed. *Permaculture* is such a guide. It has been written for those people who conserve energy, aid local self reliance, and provide for themselves, which, really, is the essence of sustainable development.

The premise of this book is that there are systems of housing, feeding, and employing people that do not negatively impact the earth's ecosystems and can be continued indefinitely without depletion of any resources (hence the title, permaculture, from *perma*nent agri*culture*). Bill Mollison discusses both very large scale and very small systems. For instance, there is a description of the layout and the daily, weekly, and seasonal workings of a small mixed farm that uses no biocides. Because of polyculture, it is as productive as a conventional agri-business employing chemical fertilizer, herbicides, and pesticides.

On a larger scale, Mollison provides tools for the analysis and design of the interaction of people with the natural world. These interactions may be as extensive as the design and development of a polycultural aquaculture system, or as innocuous as the selection and placement of trees for a windbreak.

A glance at the table of contents shows the encyclopedic approach needed to redesign the way humans affect each other and the world. Following the introduction are chapters on:

Concepts and Themes,
Methods of Design,
Pattern Understanding,
Climactic Factors,
Trees and their Energy Transactions,
Water,
Soils,
Earthworking and Earth Resources.

These chapters constitute a compendium of tools to work with the real world, which is described in the last chapters:

Humid Tropics,
Dryland Strategies,
Humid to Cold Climates,
Aquaculture,
The Strategies of an Alternative Global Nation.

Each chapter ends with either a summary of principles pertinent to the chapter contents or a designer's checklist, and a section on references and further reading. In the middle of the book, 128 colour plates provide vivid illustrations of themes or components from each chapter.

"Trees and their Energy Transactions," the chapter on trees, vividly illustrates the crucial need for new perspectives on global biodiversity issues. Mollison

describes in great detail the intricate and inextricable links between forests, soils, and climate. Forests have played a large part in creating soils by mechanical (root pressure) and chemical (humic acid) action on rocks and minerals. Addition of organic materials and life processes (decomposers) boosts soil creation. Forests also have strong effects on local climate. They provide nuclei for rain in the form of bacteria, pollen, and natural sulphur particles. They modify wind streams by compressing streamlines and inducing turbulence in airflows. They induce condensation of water vapour, especially at night, and moderate snow, rain and meltwater cycles. Forests can also rehumidify the air in large enough amounts to form new rain clouds. These links have been little investigated or discussed because most studies of forests have been from a lumber and pulpwood production viewpoint, or of relatively narrow studies of specific aspects of forest ecology. These ecological studies are desirable, but cannot, in themselves, give the spatial and temporal perspective required to see the interdependence between forests and climate.

This is not a dry didactic tome. Mollison includes the occasional witticism: "Few people today muck around in earth, and when on international flights, I often find I have the only decently dirty fingernails."

Mollison also throws in some deliberately provocative statements: "It is past time to tax lawns (or any wasteful consumption) and to devote that tax to third world relief. I would suggest a tax of $5 per square meter for both private and public lawns, updated annually, until all but useful lawns are eliminated."

He even presents a convincing case against the argument that widespread or complete vegetarianism practised by humans would lessen the world food shortage problem. The only ecosystem in which a high proportion of vegetation is edible by humans is the home garden. Much plant material in almost all other ecosystems cannot directly nourish humans. Omnivorous diets make the best use of complex natural systems, hence the use of rabbit, chicken, or pig foragers. Mollison also points out that soybeans are one of the few crops wholly owned by the multinationals.

I found only one error in the book, and that was a supposition in the Aquaculture chapter that carp, *Cyprinus carpio*, would feed directly on algae. They do not, although they do feed on the epiphytic organisms associated with algae.

This is an essential book for those who "manage" natural resources, for students of the natural world, legislators, farmers, and ordinary people who want to be more self-reliant and make a difference. [Noel Alfonso, Technical Editor]

Essentials of conservation biology

By Richard B. Primack. 1993. Sinauer Associates Inc., Sunderland, Massachusetts, U.S.A. 564 pp. ISBN 0-87893-722-6.

This modern introductory textbook covers the rapidly evolving field of conservation biology and combines theory with applied and basic research. It includes an extensive bibliography with over 1,000 references, making it valuable to graduate students and researchers. [Publisher]

Climate Change and its biological consequences

By David M. Gates. 1993. Sinaeur Associates Inc., Sunderland, Massachusetts, U.S.A. 280 pp. ISBN 0-87893-224-0

Although the magnitude of the projected temperature change is not as great as the climate changes the Earth has experienced in past eons, the rate at which these changes are occurring—over decades rather than centuries or millennia—is virtually unprecedented. This temperature change may stress the adaptive responses of many species beyond the point where they can survive. [Publisher]

Ecology and our endangered life-support systems

By Eugene P. Odum. 1993. Sinauer Associates Inc., Sunderland, Massachusetts, U.S.A. Second edition. 301 pp. ISBN 0-87893-634-3.

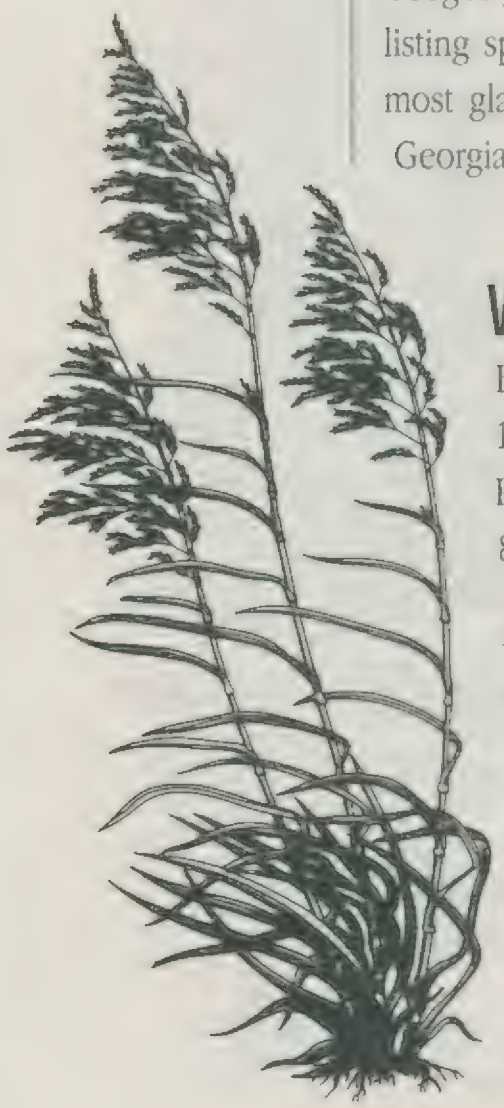
This second edition has updated and expanded coverage of experimental life-support systems, ecozones, diversity, energetics, agroecology, succession, mutualism, evolution, ecological economics, waste reduction, global concerns and ecosystem types, especially wetlands. Because the relevance of the principles discussed to human affairs is stressed throughout, this book can be considered a guide to human ecology. [Publisher]

Status of freshwater fishes of the United States: Overview of an imperiled fauna

By Melvin L. Warren and Brooks M. Burr, 1994. Fisheries 19(1): 6-18.

Conservation biologists have begun a concerted effort to educate the public, resource administrators, and politicians about the decline of temperate ecosystems, including their fishes. The United States harbours the most diverse temperate freshwater fish fauna in the world with about 790 species represented, about 90% of which are nongame fishes. From a state-by-state perspective, diversity of fishes in the United States is concentrated in the South, primarily in Alabama, Kentucky, Georgia, Mississippi, Tennessee, and Virginia, each of which supports at least 200 native fish species. Endemicity of fishes is high in both the South and the West; in the latter region, up to 70% of fishes in some drainages (e.g., Colorado River) are endemic or native only to that area.

Imperilment is apparently not confined to particular taxonomic groups. Of the five most diverse fish families in the United States, total imperilment ranges from 7% in the Centrarchidae to 50% in salmonids that do not migrate to the sea, and indicates widespread and pervasive degradation of aquatic habitats. Imperilment is most acute in areas of high diversity and / or endemicity (i.e. the southern and western states). States with 20 or more imperiled species include Alabama, Arizona, California, Georgia, Nevada, New Mexico, North Carolina, Oregon, Virginia, Tennessee, and Texas. Backlogs in listing species as federally threatened or endangered are most glaring (10 or more backlogged taxa) in Alabama, Georgia, Nevada, and Tennessee. [Authors' abstract].



Wetlands

By Pamela Hickman, illustrated by Judie Shore. 1993. Federation of Ontario Naturalists, Kid Can Press Limited, Toronto, 96 pp. ISBN 1-55074-126-8. $10.95.

At last, we have a colourful and readable book on wetlands, specifically designed and illustrated for children ages 8 to 12, with enough factual and detailed information to warrant its use in the classroom. Pamela Hickman and her illustrator, Judie Shore, have packed into a few pages an introduction to and investigation of both freshwater and marginal marine wetland ecosystems.

The author introduces various concepts of wetlands, including plankton, various wildlife closeups, and conservation strategies, including easy-to-follow experiments and laboratory or field projects. The book becomes virtually a field guide and laboratory manual at the same time. The full-colour illustrations are done with an eye for scientific accuracy, allowing the student to identify microscopic and larger plant and animal life associated with wetlands.

The final pages are devoted to saving our wetlands, drawing on what we, as students of nature, can do to help preserve these endangered and very important ecosystems. This book provides a starting point on which to build an appreciation for our wetlands. It should become a standard reader for the elementary school science classroom. [David M. Jarzen, Book Review Editor]

Invasive plants of natural habitats in Canada.

By David J. White, Erich Haber, and Cathy Keddy. 1993. Report prepared for the Canadian Wildlife Service, Environment Canada by the Canadian Museum of Nature. 121 p. [Copies available from: Habitat Conservation Branch, Canadian Wildlife Service, Environment Canada, Ottawa, ON K1A 0H3, ISBN 0-662-20476-X. Également disponible en français sous le titre *Plantes envahissantes des habitats naturels du Canada*]

This report comprises a review of the vascular species that are invading wetlands and uplands and the impact of this colonization on the natural ecology of habitats. The authors considered introduced plants to be invasive if they displaced original components of the ecological community. Natural areas were defined as habitats that are largely undisturbed and support native plant species in that site. The report concentrates on invasive alien plant species (although the authors recognize that colonizing and competitive native taxa may also strongly impact natural habitats). It also focuses on the biology and phytogeography of the major and minor invasive alien plant species that are harmful to native vegetation and ecological succession.

In preparing the report the authors distributed three survey forms to 42 botanists across Canada. The forms, of which 35 completed survey forms were received, comprised a ranking system for plant species of concern based on 1) major invasive species regardless of the habitat occupied, 2) invasive wetland species, and 3) invasive upland species.

The major invasive species for each of the two latter categories, wetland and upland aliens, are discussed under several headings. The taxonomy, distribution, biology, ecology, present status and potential threat, control measures (both chemical and biological), survey summary, and content are covered. A bibliography of scientific and related reference material concludes each account. The minor species are treated in lesser detail following major species accounts. A more comprehensive bibliography appears at the conclusion of the report.

One of the most valuable features of the report is the distribution maps. For example, leafy spurge is depicted by two maps, the first showing its range in 1933, the second showing the range of its spread up to 1980. Unfortunately, the leafy spurge map does not indicate the very dense stands which now occur in the Guelph-Cambridge areas of Ontario and in parts of the southern prairie provinces.

My major criticism of this work centres around the method of conducting the survey, the herbicide recommendations, and the information on weed legislation given in Section III. It is apparent when one examines the report that a species list was provided to the respondents upon which they should base their rating. For instance, one respondent indicated that wild marjoram (*Origanum vulgare*) should have been included on the list. This casts the report as being somewhat arbitrary.

Several questions needed to be answered regarding this report. For instance, why was tansy ragwort (*Senecio jacobaea*) not included? How does reed grass (*Phragmites australis*), a strongly invading native species, impact on natural areas in the St. Lawrence lowlands or elsewhere where it is spreading? In many situations it is as strong in competitive ability as the introduced purple loosestrife. Reed canary grass (*Phalaris arundinacea*) is both native and introduced, and both are indistinguishable from each other; why was it included? It is also well known that introduced downy chess (*Bromus tectorum*) has become invasive in upland situations in southern areas of western Canada. The most devastating weedy aliens occurring in British Columbia and southwestern Alberta are the diffuse and spotted knapweeds (*Centaurea* sp.). Considerable literature is available related to the history, spread, and biological control of these species; it is unfortunate they were omitted in the report.

One major conclusion of the report supports further efforts in the field of biological control of alien plant species. The review of current and past biological control efforts on many of the indicated species is laudable and accurate. It is valuable to have this information recorded in the report.

The section on chemical control of aliens with herbicides would have been better omitted. Control of weeds with herbicides is a provincial responsibility, and several of the provinces have published mandatory control recommendations and application procedures covered by statute. Some of the recommended herbicide literature in the report has it origin in publications from the United States. It will be difficult for readers of the report to harmonize the Canadian and American recommendations. In addition, the Plant Quarantine Act, administered by Agriculture Canada, was strengthened to include consideration of the risk of importing alien plant species. This step should help in the protection of both the environment and the agroecosystem from potential problems associated with undesirable alien species.

Overall, this report is of high quality, and considers many of the factors associated with documenting and managing alien and exotic species. Readers will reap benefits from the reference materials and maps as they obtain additional information related to this important subject. The report was published in partnership with Environment Canada, Canada's Green Plan, the Canadian Museum of Nature, and North America Wetlands Conservation Council (Canada).

Clifford W. Crompton,
Agriculture Canada, Research Branch,
Centre for Land and Biological Resources Research,
Biological Resources Division, C.E.F., .
Ottawa, Ontario K1A 0C6

A classification of living and fossil dinoflagellates

By R.A. Fensome, F.J.R. Taylor, G. Norris, W.A.S. Sarjeant, D.I. Wharton and G.L. Williams. 1993. Micropaleontology Special Publication Number 7, American Museum of Natural History, New York, 351 pp, ISSN 0160-2071, paperback US$90.00.

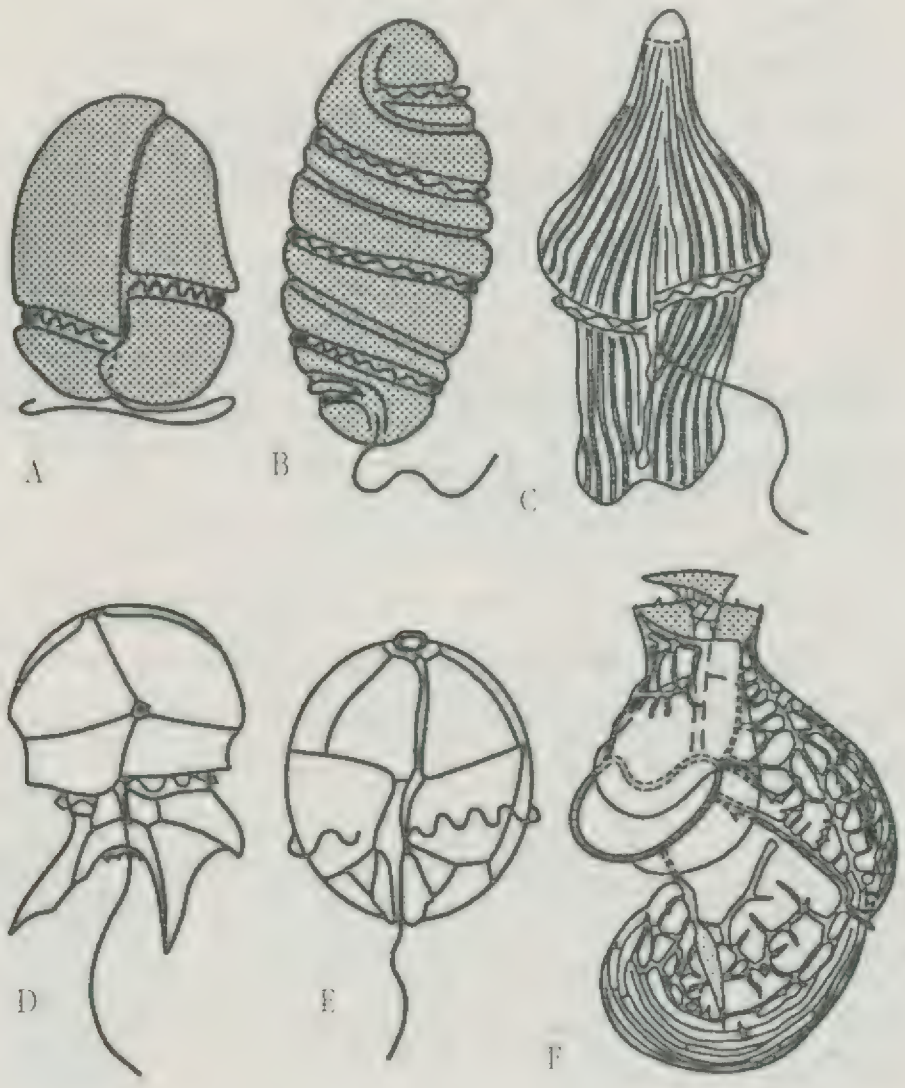
Biodiversity studies, whether at the genetic, species, or ecosystem level, frequently neglect or exclude protist diversity. The protists are primitive single-celled organisms that collectively account for the vast majority of the Earth's biodiversity.

Dinoflagellates are protists that are found in most aquatic environments and constitute the free-swimming plankton on which other organisms depend for food. They are a major component of the marine phytoplankton and, therefore, important as primary producers. An understanding of their biology, distribution, and classification is basic to an assessment of their diversity.

Fensome and his co-authors have produced a beautifully illustrated and carefully written volume, which addresses the first step in dinoflagellate biodiversity studies—an appreciation of their classification. The book covers in detail the morphology and tabulation of dinoflagellate groups, followed by what appears to be a complete systematic outline to family level, including the type genus. Each family is fully illustrated (line drawings) with the salient features of selected taxa.

The references (33 pages) are a valuable source of data, often including early papers now very difficult to locate. Four appendices cover a Glossary of Terms, Previous Classifications, Index to Assignments of Genera, and Species Names Cited in the Text. A complete index of all taxonomic names with authorship ends the book.

Fensome, *et al.*, have done their homework and have produced a "handbook" reference-type volume that will become the "standard source book" for years to come.
[David M. Jarzen, Book Review Editor]



In Figure 1 of the book *A Classification of Living and Fossil Dinoflagellates*, 20 extant dinoflagellates are featured, showing morphological variations. Six are reproduced here:
A. *Katodinium*,
B. *Cochlodinium*,
C. *Baclechina coerulea*,
D. *Heterodinium extremum*,
E. *Blepharocysta splendor-maris*,
F. *Histioneis dolon*.
Art courtesy of Micropaleontology Press.

The natural history of inbreeding and outbreeding: theoretical and empirical perspectives.

Edited by Nancy Wilmsen Thornhill. 1993. The University of Chicago Press, Chicago and London, 584 p. ISBN 0-226-79854-2 (cloth; US$80.00 & £63.95) ISBN 0-226-79855-0 (paper; US$32.50 & £29.95).

Twenty-six experts in evolution, behaviour, and genetics offer timely perspectives on inbreeding and outbreeding. (Outbreeding is the mating of individuals less closely related than average pairs in a population, or from different populations; inbreeding is the reverse.) By bringing together different perspectives on the frequency and magnitude of inbreeding and outbreeding in wild and captive populations, the authors explore the causes of various mating patterns and their implications for fitness and for genetic diversity within and among species.

This volume explores the implications of mating patterns on the evolution of dispersal, mate recognition, mating systems, and fitness in mammals, birds, reptiles, amphibians, marine invertebrates, and higher plants. By providing a concise summary of current research on inbreeding and outbreeding, and pointing to issues for further research, this volume will interest graduate students and researchers in evolutionary biology, animal behaviour, ecology and conservation biology. [The University of Chicago Press Review].

This land is your land, a guide to North America's endangered ecosystems

By Jon Naar and Alex J. Naar, 1993, Harper Perennial, Harper Collins Publishers, Inc., New York, Harper Collins Canada Ltd., Toronto, 388 p. ISBN 0-06-096882-6 PB $20 CDN; $15 US.

Jon and Alex Naar are environmentalists, authors, and lecturers who have collaborated previously on *Design for a livable planet*. With this, their second effort, they have produced what might be considered a usable, reader-friendly, citizen-participation handbook on the condition and mechanisms of North America's ecosystems, with detailed action plans for their protection and restoration.

The liberally illustrated and well-documented text is divided into three parts: The Water, The Land, The People. Within each part, the authors define the major

ecosystem resources, discuss current problems, and profile specific cases of systems in danger and talk about what we can do to help preserve, protect, or restore these systems to a level compatible with human populations and needs.

Although the book covers the entire North American continent including Mexico, emphasis is placed on land and river environments within the United States. Canada, however, receives significant coverage throughout the book, including excellent discussions on the Alsek and Tatshenshini (BC), the Great Whale (Quebec), and Great Lakes aquatic ecosystems, and major terrestrial systems as tundra, boreal forest, and eastern deciduous forests.

Perhaps the major value of this book is the final section on resources, including an extensive directory of environmental organizations, pending legislation, and what we can do to influence the environmentally correct political decisions; and finally, a glossary of terms and abbreviations. Throughout the book the authors include broad references and suggestions for further reading and notes on the sources of their data.

The book is easy to read, but should best be approached as a reference base from which to seek further detailed information. Although environmental law and movements are changing rapidly, this book will serve as an excellent guide for many years to come. [David M. Jarzen, Book Review Editor]

Impacts of forestry practices on a coastal stream ecosystem, Carnation Creek, British Columbia

By G.F. Hartman and J.C. Scrivener. 1990. Canadian Bulletin of Fisheries and Aquatic Sciences 223, 148 pp.

Results from the first 17 years of a multi-disciplinary study about the effects of logging activities on a small stream ecosystem in the coastal rainforest of British Columbia have been reviewed here. The main hydrological, fluvial-geomorphological, thermal, and production relationships are integrated in four schematic illustrations. The study has revealed that each activity conducted within an overall forest management plan may affect the physical components of an ecosystem differently. Whether these effects had positive or negative impacts on fish and other stream biota depends upon the specific activity conducted, the species present, and the life stage of each species of fish.

Applications of results to land use planning are also discussed. Logging-related changes in a drainage can occur over decades of time. Although coastal streams in British Columbia are diverse, the common features that must be considered in fisheries-forestry planning are high rainfall, high hydrological energy, physical instability, low nutrient levels, and cool temperatures. Long-term case history studies, such as the one reported here, reveal ecosystem processes and permit researchers to partition climatic variability from man-induced impacts. Resource managers must be able to understand and apply such process information to other stream systems in the light of their own experience and site specific information. [From Authors' abstract]

Planet under stress: The challenge of global change

Edited by Constance Mungall & Digby J. McLaren for the Royal Society of Canada. Oxford University Press, Toronto, Oxford, New York. 344pp. ISBN 0-19-540731-8 paper, $19.95, with 83 photographs, 16 in colour, and 81 figures.

Every day brings more evidence of how the environment is being damaged and how global change has already taken effect. Acid rain, unclean air and water, global warming, drought, and famine are just some of the effects of humankind's despoiling life on the planet Earth. The Royal Society of Canada asked experts from the natural sciences, the social sciences, and the humanities to cast light on this threatening situation by telling us something about the evolutionary history of the planet, its changing dynamics, the evidence of global change, current research into it, and the possible ecological changes that will occur if the inhabitants of Earth do not learn to live in balance with its complexities—maintaining what is now called "sustainable development." This book is the result. [condensed Oxford University Press review]

Kill the cowboy

A battle of mythology in the new west. By Sharman Apt Russell. 1993. Addison-Wesley Publishing Company, Reading, Massachusetts. 217 pp. Hardcover, ISBN 0-201-58123-X. US$20.00, Can$25.95.

The environmental impacts of resource management on forests, croplands, and fishing grounds is widely

discussed. Impacts of range or grazing land management have been less widely discussed in global environmental fora. However grazing land, worldwide, occupies an area equal to cropland and managed forests combined. Therefore, how we manage grazing land is significant at local and global levels.

This book portrays the social interactions taking place in the American West as concerns increase over the effects of cattle grazing on ecosystems of public lands. A hot political battle is under way between the various users of these open and mixed forest grasslands, and public discussions are liable to be fiery. Although the author is an environmentalist, the book is unique because it openly airs opinions of government land managers, ranchers, environmentalists, recreational land users, researchers, and others. Participants are allowed to speak their minds and feelings, revealing the mythologies they weave and from which they are created.

The author has been skilful in eliciting opinions and in juxtaposing different points of view. This produces a very readable text, yet one which is very instructive. No matter which side of the fence you are on—or even if you are sitting *on* the fence—you will learn something. Hope lies in the fact that some ranchers and environmentalists are listening and learning from one another. Some of the environmental issues and principles will be useful in other parts of the world where grazing affects wildlife and wild lands. I liked everything about this book, except for the title. [D.E.M.]

The range

By Sherm Ewing, 1990. Mountain Press Publishing Company, P.O. Box 2399, Missoula, Montana, U.S.A. 59806. 284 pp. Paperback, ISBN 0-87842-267-6.

Those interested in the previous book may also be interested to read *The range*. This book deals with the border country between Canada and the U.S.: Montana, Alberta and Saskatchewan. In their own words, ranchers, range and wildlife managers, and old-timers tell stories about life on the eastern slope of the Rocky Mountains. The stories are woven skilfully into a historical narrative about the area, where the First Nations and buffalo used to reign to the cattle, sheep, horses, wildlife, and the few crops that preside today. Although the book crosses many boundaries and voices many viewpoints (ranchers, farmers, sportspeople, ecologists, etc.), it always focuses on the land and our dependence on it.

The book gives one to three pages to different persons to speak on the buffalo range, range settlement, hard times and range horses, range weather, a range camp, range ideas, range know-how, and range grasses. Each speaker is introduced with a tiny sketch, giving the reader a bit of the feeling of the speaker's personality. Speakers include:

- Bob Ross, a modern ranchman, who grew up in central Montana when the range was free;
- Joe Gilchrist, raised in a sod-roofed homestead shack in the big, open southwest corner of Saskatchewan, cowboy at 13 and now 89, slim, straight and full of interest and good humour;
- Ferry Carpenter, Colorado lawyer and breeder of purebred horses, once a bureaucrat in charge of divvying up the range;
- Billy Big Spring, Indian rancher, politician, artist, philosopher, and World War II veteran, who speaks of survival in the Blackfoot Reservation, a welfare state, where times are always tough;
- Alex Johnston, Alberta historian, range scientist and ecologist;
- Jim Little, who manages the range for future generations;
- Douglas R. Dewey, a research geneticist, who has explored Asia as part of a career in plant breeding; and
- Jonathan Fox III, cigar-chewing, yarn-spinning, world-class livestock judge and breeder, who recalls how his father sold solid horsepower.

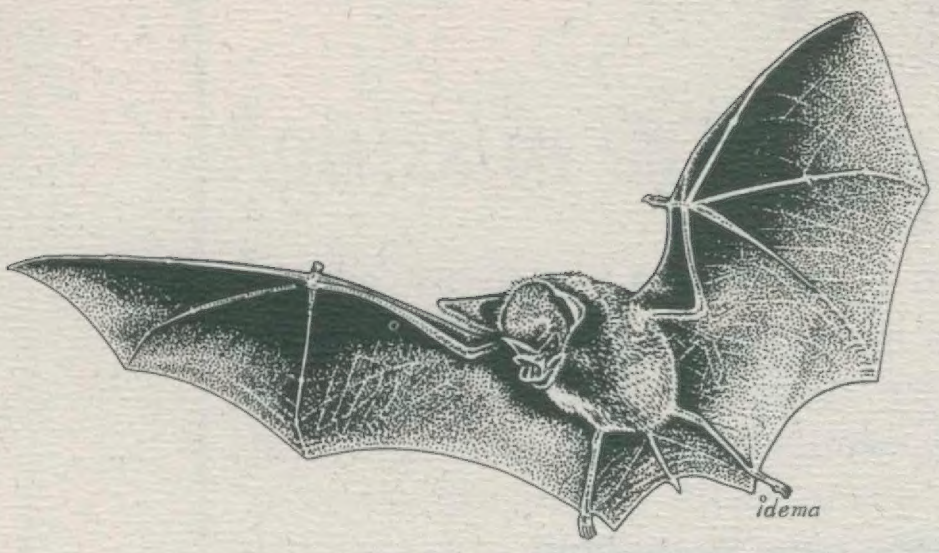
The book ends with an epilogue on range rotation, a register of the people who speak in the book, a list of range plants, a glossary, notes on the chapters, a bibliography, and an index.

Interspaced with the stories are photos of the landscape, ranching in the old days, and people. *The range* is an enjoyable and informative read whether you are interested in ranching, wildlife, or history. The vignettes show how people shaped the land and how the land shaped the people. [D.E.M.]

Bats

by M. Brock Fenton, 1992, Facts on File, New York, New York, 207 pp., US$55.00. ISBN 0-8160-2679-3

This book deals with all aspects of bats and their biology in a non-technical, easy style. It starts with an introduction to the order, focusing on the anatomy, origins, and the adaptation that sets bats apart from all other mammals—flight. The introduction is followed by a practical chapter on how to study bats, including sections on catching, marking and identifying them, as



well as other approaches to study them. The general biology of bats is covered in half a dozen chapters (3 to 8) dealing with echo location, bats' other senses, orientation and migration, what bats eat, where they roost, their social organization and ways of communication, and factors affecting their survival. Chapter 9 gives an overview of the 12 families of bats, and the vampire bats receive special attention in a chapter of their own. The three concluding chapters cover bats and public health, conservation and bats in a cultural context. The book is amply illustrated throughout. Many of the beautiful colour photographs are by the author.

One of the strengths of this book is that much of its content is drawn from personal observation and experience. The author has studied bats for over 30 years in North and Central America, Africa, Australia, and New Guinea. His curiosity, persistent enthusiasm, and dedication to his chosen group, which comes through in the pages of this book, are necessary prerequisites for the acquisition of such a wealth of knowledge of a particular group of organisms. It is fortunate that there are still places where such qualities are valued and where they can bear fruit. Had the author been employed in one of Canada's public institutions charged with instructing and instilling interest in, knowledge of, and appreciation and respect for nature, chances are that his book would never have seen the light of day.

There are some 900 species of bats in the world today, which makes them the largest order of mammals after the rodents. Aside from comprising a large number of species, bats also display a high degree of adaptive radiation, particularly in tropical regions, and therefore contribute significantly to biological diversity. Many bats are keystone species in their ecological communities. For example, the nectar- and pollen-feeding bats and those that feed on fruit are essential in the pollination and seed dispersal of many tropical rain forest trees. Although many species play fundamental roles in their ecological communities, very few species have been studied thoroughly. The ecology and behaviour of the vast majority of species remains unknown. It is hoped that books like this one will stimulate the curiosity of more people and promote further investigations into the lives of these fascinating creatures.

I unhesitatingly recommend this book to anyone interested in nature. The book is packed with information, palatably presented, and is aesthetically pleasing.

Dr. C.G. van Zyll de Jong, R.R. 3,
North Augusta, Ontario K0G 1R0

Erratum

Thank you to Ronald Pine, Illinois Mathematics and Science Academy and The Field Museum, Chicago, for pointing out an error in *Global biodiversity* 3 (2), page 5. Coatis are not just found in South America, as stated. They range from South America up through Central America and Mexico into the southwestern U.S.A.

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A Brief Guide to
Vermicomposting

Why should I vermicompost?

Up to 30% of household waste is organic matter, and in much of the developed world, its ultimate fate is to be sealed in plastic bags and trucked to landfill sites. There is a growing movement towards composting this material in outdoor bins, but this is impractical in the winter, for apartment dwellers, or for people with limited access to the outdoors. One potential solution to the waste disposal problem is to use the ecological services of oligochaetes, or worms. More and more people are starting to vermicompost indoors. They find it easy, straightforward, and convenient. By recycling food waste, they are saving energy costs, reducing the use and future need for landfill sites, reducing waste disposal costs, and producing free, high quality organic fertilizer for their house and garden plants. Vermicomposting, then, is not only the answer for most people, it is a rewarding, interesting and educational means of dealing with kitchen waste.

How do I set myself up?

Complete vermicomposting kits (container, bedding, and worms) are available through mail order (see environmental magazines) or in specialty stores. Commercial bins are about the size of recycling blue boxes. Most vermicomposters agree that this size is sufficient for one vegetarian person or two people who do not generate large volumes of compostable materials.

Or you can acquire the three components separately. Suitable containers, such as recycling blue boxes or plastic storage bins, can be inexpensively purchased, bedding made from shredded newspaper, and worms purchased separately or given by friends. The worms used in vermicomposting have a variety of common names – red worms, red wrigglers or manure worms – but are generally one of two species: *Eisenia foetida* or *Lumbricus rubellus*. *Lumbricus terrestris*, the common earthworm, is not a suitable candidate for vermicomposting. Red worms can be placed in bedding in a ventilated container with air holes along the sides and bottom of the container. The bedding should be moistened to the wetness of a squeezed-out sponge, the first food can be added, and the surface covered with a lid or black plastic to hold in moisture and block out light (red worms are photophobic).

What foods can I compost?

Any food waste can be used, but meats and dairy products should be used in limited quantity, as putrefaction and a foul odour can set in quickly. This is the only occasion when odour may be a problem—as long as the food placed in the bin is given a light coating of bedding. From time to time, other species such as springtails, fruit flies, Enchytraeids (white worms), centipedes, millipedes, or mites may appear in the bin ecosystem. They all contribute to the breakdown of kitchen wastes. Remove the centipedes as they prey on red worms.

What happens when my bin is full?

Periodic removal of worm castings and replacement of bedding ensures a steady supply of fertilizer and a healthy worm population. Removal can be done in a variety of ways. For example, bin contents can be piled in a number of small piles on a plastic sheet on the floor. To avoid the light, the worms will move toward the centre of each pile. The vermicompost on the outside of the piles can be removed and the worms placed into new bedding in the bin. Alternatively, worms, bedding, and vermicompost can be moved into one pile at one end of a bin while a new pile of fresh bedding and new food is placed at the other end. Over time, worms will migrate to the newer food source and leave a worm-free pile of vemicompost, which can then be easily removed and the process started again.

[Noel Alfonso, who condensed some of this material from Worms eat my garbage, *Mary Appelhof, Flower Press, Kalamazoo, Michigan. ISBN 0-942256-03-4)*

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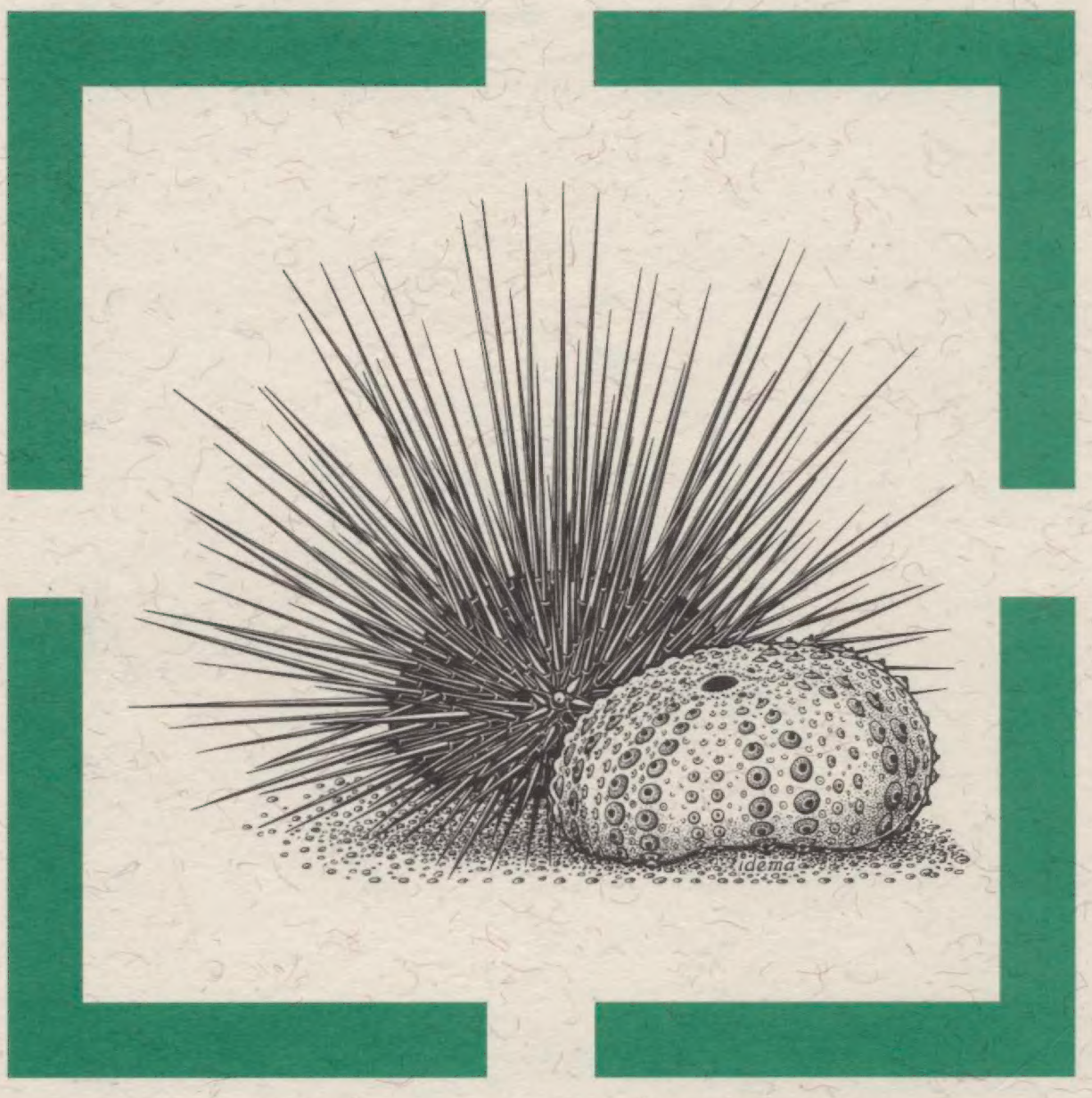

Black long-spined sea urchin
Diadema antillarum Phillipi

Wildlands can wake us to forgotten harmonies if we return as participants who belong there rather than as appreciative aliens or as subjugating conquerors.

Jim Corbett, 1991, ***Goatwalking***

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